Pacific Stock Assessment Review Committee (PSARC) Annual Report for 1986

M. Stocker (editor)

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Fisheries Research Branch
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Nanaimo, British Columbia V9R 5K6

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PACIFIC STOCK ASSESSMENT REVIEW COMMITTEE
(PSARC)
ANNUAL REPORT FOR 1986

by

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Chairman's Report for 1986

This is the first Annual Report of PSARC. In 1986, its second year of operation, a formal PSARC process has been adopted in the Pacific Region. This came about by approval of the terms of reference on February 16, 1986 by the Regional Director-General Mr. P.S. Chamut. Here is some background information that led to the implementation of a stock assessment review process in the Pacific Region.

In August of 1983 W.G. Doubleday (Ottawa) made a proposal for a Pacific Region Scientific Advisory Committee based on the CAFSAC model, which is operating in the Atlantic Region. In February of 1985 Mr. W. Shinners then Regional Director-General announced the implementation of a stock assessment review process, and appointed Mr. D. Schutz the first Chairman. The first series of reviews of groundfish, herring and shellfish stock assessments took place in the fall of 1985. No salmon participation took place in that year. The advice emerging from the reviews was summarized in memorandum form and sent to Branch Directors. In 1986 I was appointed chairman with instructions to develop PSARC formally for improving stock assessment methodology and capability in the region with special emphasis on salmon. In 1986 PSARC again reviewed groundfish, herring and shellfish stock assessments. In addition three salmon programs were also reviewed: Chinook "key stream" program, Coho stock assessment, and Barkley Sound Sockeye. This annual report includes five advisory documents from these reviews. In January of 1987 the ADM Science, L.S. Parsons, was briefed on progress made by PSARC. On April 7, 1987 an implementation meeting was chaired by Mr. Chamut at the Hotel Vancouver to launch the process.

Steering Committee review of the 1986 PSARC Advisory Documents took place on May 20, 1987 in Nanaimo. The Committee's comments have been appended to the Advisory Documents in this report. The Fisheries Resource Management Executive Committee approved the release of the Advisory Documents on July 21, 1987. Since this was the first time the process ran through an annual cycle it is understandable that the approval process took extra time. All efforts are made to ensure timely release of Advisory Documents for PSARC's third year of operation in 1987. This will allow incorporation of the biological advice emerging from the PSARC process into the development of fishing plans for the Pacific Region fisheries.

This document is the result of a process. It presents the efforts of the stock assessment community in the Pacific Region. The principal contributors are those authors listed in the PSARC Working Paper Index for 1986. Numerous other members of DFO staff played key roles in producing this effort. As editor my role was merely one of providing logistic and organizational support for producing this document.

I want to take the opportunity to thank all those who contributed so much to make the PSARC process a reality. I am grateful to my colleagues on the steering committee whose professional approach has helped me to bring PSARC to fruition. I have also been fortunate to have the guidance of the regional Fisheries Resource Management Executive Committee in this assignment.

M. Stocker
Chairman

Rapport du président pour 1986

Le présent document constitue le premier rapport annuel du Comité d'examen des évaluations des stocks du Pacifique (CEESP), en troisième année d'activité. Le 16 février 1986, M. P.S. Chamut (directeur-général régional) a approuvé le mandat du CEESP, officialisant ainsi le processus d'examen des évaluations des stocks du Pacifique. Les paragraphes suivants présentent quelques données documentaires qui ont mené à la mise en oeuvre d'un processus d'examen des évaluations des stocks dans la Région du Pacifique.

En août 1983, W. G. Doubleday (Ottawa) proposa la création d'un Comité scientifique consultatif des pêches dans la Région du Pacifique en prenant le CSCPCA comme modèle. En février 1985, W. Shinners qui était à ce moment-là le directeur-général régional annonça la mise en oeuvre d'un processus d'examen des évaluations des stocks et nomma D. Schutz comme premier président. La première série d'examens des évaluations des stocks de poissons de fond, de hareng, de mollusques et de crustacés eut lieu à l'automne 1985. Le secteur de la pêche du saumon ne fut pas considéré cette année-là. Les conseils dégagés de ces examens ont été résumés en notes de service et envoyés aux directeurs de chaque direction. En 1986, on me nomma président et on me chargea du développement officiel du processus d'examen afin d'améliorer les méthodes et la capacité d'évaluation des stocks dans la région du Pacifique tout en mettant l'accent sur le saumon. En 1986, le CEESP examina à nouveau les évaluations des stocks de poissons de fond, de hareng, de mollusques et de crustacés. De plus, on examina les trois programmes suivants sur le saumon: inventaire des principaux cours d'eau à saumon quinnat, évaluation des stocks de saumon coho et étude du saumon rouge de la baie Barkley. Le présent rapport annuel comprend cinq documents consultatifs sur ces examens. En janvier 1987, L. S. Parsons (SMA Sciences) a été informé des progrès réalisés par le CEESP. Le 7 avril 1987, M. Chamut a présidé une réunion de mise en oeuvre du processus à l'Hôtel Vancouver.

L'examen, par le comité directeur, des documents consultatifs présentés par le CEESP en 1986 a eu lieu le 20 mai 1987 à Nanaimo. Les commentaires du comité sont inclus à l'annexe des documents consultatifs du présent rapport. Le 21 juillet 1987, le Comité exécutif de gestion des ressources halieutiques a approuvé la diffusion des documents consultatifs. Étant donné que c'était le premier cycle annuel du processus, il est comprenable que le processus d'approbation ait été plus long. Tous les efforts nécessaires sont déployés afin d'assurer la diffusion opportune des documents consultatifs pour la troisième année d'opération du CEESP en 1987. On pourra ainsi inclure les conseils biologiques dégagés du processus d'examen dans l'élaboration de plans de pêche dans la Région du Pacifique.

Le présent document est le résultat d'un processus et montre les efforts des participants dans l'évaluation des stocks de la Région du Pacifique. Les principaux collaborateurs sont ceux énumérés dans l'index du document de travail du CEESP de 1986. De nombreux autres membres du personnel du MPO ont joué des rôles-clés dans la production de ce document. À titre d'éditeur, mon rôle s'est purement limité au soutien logistique et à l'organisation.

Je prends l'occasion pour remercier toutes les personnes qui ont tant contribué à la réalisation du processus d'examen. Je suis reconnaissant envers nes collègues du comité directeur dont le professionnalisme m'a aidé à réaliser le mandat du CEESP. J'ai aussi eu la chance d'avoir des conseils du Comité exécutif régional de gestion des ressources halieutiques pour la réalisation de mes fonctions.

M. Stocker, président

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Section I

Report on Committee Activities

Terms of Reference
Pacific Stock Assessment Review Committee
(PSARC)

Organizational Structure

PSARC is a Departmental Committee that reviews biological advice on the status and management of Pacific fisheries resources. The Committee reviews methodologies and criteria employed in the stock assessment process, and formulates and evaluates methodologies employed to establish management plans and to assess local fisheries. In terms of a broad definition, PSARC encompasses the stock assessment community of D.F.O. in the Pacific Region responsible for providing biological advice to senior management in the Region. PSARC is controlled, organized and administered by a steering committee, which reports to the Resource Management Executive Committee - Pacific. The Chairman reports to the Director-General, and will serve for a 2-year term.

The technical work of the organization is performed by subcommittees, organized on a species or subject basis. Subcommittees are established and disbanded by decision of the Steering Committee and report to it.

Terms of Reference

1. PSARC is responsible for (1) reviewing and evaluating biological advice and technical advice on the status and management of Pacific fisheries resources, and (2) evaluating estimation and assessment methods and criteria used in the Region.

2. PSARC will formulate and evaluate methodologies for assessment and decision making for Pacific fisheries, and will advise the Resource Management Executive Committee of sound and appropriate methods for fisheries management in the Region.

3. PSARC shall provide scientific and technical advice to the Resource Management Executive Committee - Pacific on matters relating to fishing statistics, sampling of catches, information needs for stock assessments, and coordination of resource assessment and related projects between Branches in the Pacific Region.

4. PSARC will identify resource assessment-related research priorities, and by so doing, will provide input into the regional planning process.

5. PSARC will endeavour to ensure liaison with other regional committees. Such liaison will include mutual referral and joint meetings with other fora as required so as to ensure consistency of biological advice with long-term Pacific fisheries management objectives.

The Steering Committee

Composition

The Steering Committee includes 16 members as follows:

1 Chairman
1 F.R.B Section Head from Salmon, or delegate
3 F.R.B Section Heads from Marine Fish (Groundfish, Herring, and Shellfish), or delegate
5 Subcommittee Chairmen
1 Past-Chairman
1 Head, Biological Services, Fisheries Branch
1 Chief, Resource Allocation and Industry Liaison, Fisheries Branch
1 Delegate from Regional Planning and Economics Branch
1 Delegate from S.E.P.
1 Delegate from Ottawa

The immediate past Chairman and appointed members will serve on the Steering Committee for a 2-year term.

Responsibility of the Committee

The Steering Committee is established to provide a framework for reviewing Subcommittee biological advice that goes forward to senior management and to take the responsibility for advice from individuals of the stock assessment community and place it in the hands of the corporate structure.

The Steering Committee reviews the Subcommittee reports to ensure all relevant information has been evaluated and thoroughly analyzed, and to formulate appropriate biological advice on management questions in the broader context of Departmental policy. It is also vested with the responsibility for identifying weak areas in the scientific database and methodology used by the Subcommittee to reach conclusions and to recommend corrective actions. Items may be referred back to the Subcommittees for further consideration or be accepted as a basis for advising senior management in the form of Advisory Documents or memoranda.

PSARC has the responsibility of generating and providing biological advice to the Resource Management Executive Committee.

Responsibility of Members

It is the responsibility of members of the Steering Committee to attend all regular meetings if possible regardless of whether items being discussed are in their area of expertise in order to provide a broad-based evaluation of biological advice generated from PSARC. If the members cannot attend meetings they should appoint an alternate for meetings at which they are unable to be present.

The definition of a quorum will be left to the discretion of the Chairman.

Members are required to send copies of all correspondence and reports pertaining to PSARC business to the Chairman so up-to-date files can be maintained.

Members are required to forward editorial modifications to Proceedings to the Committee Chairman; they will not be discussed at the meeting. Corrections of a substantive nature will, however, continue to be brought to the Committee.

Each Steering Committee member, when asked for a scientific opinion on matters contained in approved Committee reports, should give the collective judgement of the Committee even if it differs from his/her personal opinion.

Schedule of Meetings

The Steering Committee has at least 3 regular annual meetings. Generally speaking, these meetings occur in the fall for reviewing subcommittee biological advice, and in early spring for planning the year's activities. Other meetings may be called as required at the discretion of the Chairman, or by request of members of the Steering Committee.

Communication with Line Management

Advisory Documents are to be submitted to the Resource Management Executive Committee.

After Advisory Documents are approved for release by the Resource Management Executive Committee, they are distributed to the management working groups, the ADM - Pacific and Freshwater, ADM Science, and other regional staff interested in receiving a copy. Notification to the Chairman of PSARC for approval of release of all Advisory Documents is coordinated through the office of the Director-General.

A listing of PSARC documentation will be forwarded to Division Chiefs and Section Heads with the request that they indicate what information they would like to receive on a routine basis. This includes PSARC Proceedings and Subcommittee Reports. This is intended to keep key managerial staff informed of PSARC activities. They are expected to respect the citation guidelines of documents so received.

Subcommittee Chairmen can communicate directly with scientific staff [illegible] this communication is restricted to matters that are for information purposes and do not have program repercussions. Items relating to program implementation and requests for assistance are to be referred to Directors for approval prior to direct communication with the departmental stock assessment community.

Subcommittees

1. The following five Subcommittees deal with the specialized areas indicated:

   Salmon Stock Assessment
   Herring Stock Assessment
   Groundfish Stock Assessment
   Shellfish Stock Assessment
   Stock Assessment Data System

2. Participating branches shall nominate Chairmen for each Subcommittee in whose work it is involved. Chairmen are responsible for communicating proposed agendas to members, participants, and reviewers and coordinating their preparations for and participation at Subcommittee meetings. Chairmanship should rotate between branches every 2 years.

3. Participation at Subcommittee meetings shall include departmental stock assessment staff as appropriate, and at the discretion of the Subcommittee Chairman, D.F.O. scientists from other Regions, and non-D.F.O.scientists, for discussion of specific topics.

4. PSARC will appoint internal reviewers from the stock assessment community to participate in Subcommittee meetings in other than their own discipline. The Steering Committee will select and approve external reviewers nominated by Subcommittee Chairmen.

Salmon Stock Assessment Subcommittee

The Salmon Stock Assessment Subcommittee of PSARC is to provide biological advice consistent with (1) sound conservation principles, and (2) optimization of production, through PSARC on the management of all salmon stocks presently exploited, or with potential to be exploited, by:

- reviewing all pertinent information and analyses, or by conducting such analyses as may be required, to establish the status of salmon stocks and to predict the effects of alternative management measures on potential yields;
- preparing biological advisory reports on salmon management as may be required by PSARC;
- maintaining a written record of the Proceedings of the Subcommittee documenting the recommendations of the Subcommittee, the scientific basis of such recommendations, and resultant management actions;
- critically reviewing externally published reports of scientific research, and commenting on matters relevant to the Subcommittee's mandate;
- reviewing stock assessment-related research programs on salmon, and commenting on their relevance and effectiveness in relation to management of these resources;
- providing a forum for coordination of stock assessment related research programs on salmon;
- reviewing research requirements for salmon resource management, and recommending initiation of such programs as may be required to PSARC.

Herring Stock Assessment Subcommittee

The Herring Stock Assessment Subcommittee of PSARC is to provide biological advice consistent with (1) sound conservation principles, and (2) optimization of production, through PSARC on the management of all herring stocks presently exploited, or with potential to be exploited, by:

- reviewing all pertinent information and analyses, or by conducting such analyses as may be required, to establish the status of herring stocks and to predict the effects of alternative management measures on potential yields;
- preparing biological advisory reports on herring management as may be required by PSARC;
- maintaining a written record of the proceedings of the Subcommittee documenting the recommendations of the Subcommittee, the scientific basis of such recommendations, and resultant management actions;
- critically reviewing externally published reports of scientific research, and commenting on matters relevant to the Subcommittee's mandate;
- reviewing stock assessment related research programs on herring, and commenting on their relevance and effectiveness in relation to management of these resources;
- providing a forum for coordination of stock assessment-related research programs on herring;
- reviewing research requirements for herring resource management, and recommending initiation of such programs as may be required to PSARC.

Groundfish Stock Assessment Subcommittee

The Groundfish Stock Assessment Subcommittee of PSARC is to provide biological advice consistent with (1) sound conservation principles, and (2) optimization of production, through PSARC on the management of all groundfish stocks presently exploited, or with potential to be exploited, by:

- reviewing all pertinent information and analyses, or by conducting such analyses as may be required, to establish the status of groundfish stocks and to predict the effects of alternative management measures on potential yields;
- preparing biological advisory reports on groundfish management as may be required by PSARC;
- maintaining a written record of the proceedings of the Subcommittee documenting the recommendations of the Subcommittee, the scientific basis of such recommendations, and resultant management actions;
- critically reviewing externally published reports of scientific research, and commenting on matters relevant to the Subcommittee's mandate;
- reviewing stock assessment related research programs on groundfish and commenting on their relevance and effectiveness in relation to management of these resources;
- providing a forum for coordination of stock assessment related research programs on groundfish;
- reviewing research requirements for groundfish resource management, and recommending initiation of such programs as may be required to PSARC.

Shellfish Stock Assessment Subcommittee

The Shellfish Subcommittee of PSARC is to provide biological advice consistent with (1) sound conservation principles, and (2) optimization of production, through PSARC on the management of all shellfish stocks presently exploited, or with potential to be exploited, by:

- reviewing all pertinent information and analyses, or by conducting such analyses as may be required, to establish the status of shellfish stocks and to predict the effects of alternative management measures on potential yields;
- preparing biological advisory reports on shellfish management as may be required by PSARC;
- maintaining a written record of the proceedings of the Subcommittee documenting the recommendations of the Subcommittee, the scientific basis of such recommendations, and resultant management actions;
- critically reviewing externally published reports of scientific research, and commenting on matters relevant to the Subcommittee's mandate;
- reviewing stock assessment related research programs on shellfish and commenting on their relevance and effectiveness in relation to management of these resources;
- providing a forum for coordination of stock assessment-related research programs on shellfish;
- reviewing research requirements for shellfish resource management, and recommending initiation of such programs as may be required to PSARC.

Stock Assessment Data System Subcommittee

It is the responsibility of the Stock Assessment Data System Subcommittee to provide the scientific and technical basis for PSARC advice on catch statistics, catch sampling, and biological surveys to D.F.O. Pacific, by:

- defining the stock assessment information needs of the stock assessment community and evaluating the adequacy of information provided to meet these needs;
- reviewing Regional data management priorities, and recommending work priorities to the Computer Services Division, and review policies, procedures, and schedules to ensure they meet Regional priorities and integrate with PSARC;
- developing an integrated stock assessment data system, and reviewing stock assessment-related E.D.P. work plans and assign priorities; and
- maintaining a written record of the Proceedings of the Subcommittee documenting the conclusions of the Subcommittee, the scientific basis for such conclusions, and of actions taken by other Regional groups based on the Subcommittee's conclusions.

PSARC STEERING COMMITTEE

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List of Meetings, 1986

1. Coho Technical Committee Meeting - March 20, 1986 - Pacific Biological Station, Nanaimo.

2. Chinook Key Stream Monitoring Program Review Meeting - May 6-8, 1986 - Tally-Ho, Nanaimo.

3. Shellfish Stock Assessment Committee Meeting - May 26, 1986 - Pacific Biological Station, Nanaimo.

4. Groundfish Stock Assessment Program Meeting - May 30, 986 - Pacific Biological Station, Nanaimo.

5. Coho Technical Committee Meeting - June 16, 1986, Coast Bastion Inn, Nanaimo.

6. Herring Review Meeting - August 28, 1986 - Pacific Biological Station, Nanaimo.

7. Shellfish Stock Assessment Committee Meeting - September 2-3, 1986 - Paradise Valley Conference Centre.

8. Herring Stock Assessment Committee Meeting - September 4-5, 1986 - Paradise Valley Conference Centre.

9. Groundfish Stock Assessment Review - September 8, 1986 - Pacific Biological Station, Nanaimo.

10. Barkley Sound Technical Working Group - November 20, 1986 - South Coast Division, Nanaimo.

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H86-3:35	Herring stock estimates from diving surveys of spawn on the west coast of Vancouver Island in 1986	C.W. Haegele J.F. Schweigert
H86-4:18	Herring stock estimates from diving surveys of spawn on the North Coast of British Columbia in 1986	C.W. Haegele J.F. Schweigert
H86-5:88	Classification of spawning areas of British Columbia herring (*Clupea harengus pallasi*)	D.E. Hay
H86-6:27	Herring spawning stock biomass estimates from diving surveys for Georgia Strait in 1986	J.F. Schweigert C.W. Haegele
H86-7:20	Herring spawning stock biomass estimates from diving surveys for the Central Coast in 1986	J.F. Schweigert C.W. Haegele
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H86-13:3	1986 roe herring summary	Anonymous

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G86-3:163	Groundfish stock assessments for the west coast of Canada in 1986 and recommended yield options for 1987	A.V. Tyler and M.W. Saunders [eds.]
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I86-2:5	Inshore squid fisheries	G.S. Jamieson G.D. Heritage
I86-3:9	Offshore squid	G.S. Jamieson G.D. Heritage
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I86-5:17	B.C. Shrimp trawl fishery review	J.A. Boutillier
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I86-11:18	Recommendations for the Sooke coonstripe shrimp fishery (Pandalus danae)	J.A. Boutillier
I86-12:5	Gooseneck barnacles	G.S. Jamieson
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I86-15:6	Mussels	G.S. Jamieson S. Swarbrick
I86-16:32	A commercial sampling program for shellfish fisheries: Modeling the decision making of why and where to conduct it	J. Boutillier D. Noakes D. Heritage J. Fulton

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I86-24:3	Horse clams	N. Bourne
I86-25:10	Geoduck clams	R. Harbo J. Fulton

4) Salmon

586-1:12	Forecasts of 1986 adult sockeye (Oncorhynchus nerka) returns to 21 British Columbia outer coastal lakes	K. D. Hyatt E. Rome
S86-2:28	Use of a run timing model to provide in-season estimates of sockeye salmon (Oncorhynchus nerka) returns to Barkley Sound, 1985	G. J. Steer K. D. Hyatt
S86-3:89	Pacific Region salmon management plan: Chinook	Anonymous
S86-4:74	Pacific Region salmon management plan: Coho	Anonymous
S86-5:27	Stock assessment report on coho salmon	R. K. Kadowaki et al.

Section II

Advisory Documents

Pacific Stock Assessment
Review Committee

PSARC Advisory Document 86-1

Advice on the Management of Pacific Herring Stocks in 1987

This advisory document is the result of the 1986 herring stock assessment process, summarizing biological advice on the management of Pacific herring stocks. At its meeting of August 28, PSARC reviewed the 1986 herring stock assessment document. The status of herring stocks was reviewed at the Herring Stock Assessment Committee Meeting September 4-5, 1986. Their recommendations were discussed at the Herring Management Working Group meeting September 17-18, 1986, and they developed B.C. herring allocation proposals and alternative fishing plans.

The management policy for B.C. herring is a strategy of trying to remove a constant 20% of the spawning population in conjunction with a CUTOFF. The CUTOFF provides a documented method for a pre-season justification of a fishing closure, insuring a buffer against over harvesting.

Catch Trends

Herring in British Columbia waters have supported commercial fisheries since 1877. Although catch records date back to 1888, reliable records of place, date, and quantity caught are available only since 1950. There was a fishery for the dry salted market in the Orient from 1904-1934. Up to 85,000 tonnes were taken in a given year. A reduction fishery, mainly by purse seining followed (1935-1967). Fish were taken during their inshore spawn migration runs from November to March. Very large catches of 200,000 tonnes in the early 1960s followed by a series of poor recruitments led to the collapse of the reduction fishery, with a closure in 1968. Cessation of the intensive reduction fishery resulted in a gradual recovery of stocks. The roe herring fishery began in 1971. Herring are caught on or near the spawning grounds by both gillnets and purse seines. Roe herring landings averaged 28,000 tonnes for the last five years.

The roe fishery first came under quota regulations in 1983. Prior to this, guidelines of anticipated roe catches were given. Roe catches and quotas (anticipated catches prior to 1983) since 1977 ('000 tonnes) are shown below:

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Queen Charlotte Islands										
Roe Catch	12.7	12.5	8.7	3.4	6.4	5.4	8.1	5.0	6.3	3.6
Roe Quota	12.7	13.6	8.7	*	*	*	*	4.6	5.1	3.8
Prince Rupert District										
Roe Catch	7.4	5.1	2.5	2.7	1.4	0.1**	0	3.5	6.5	8.3
Roe Quota	3.6	8.2	1.8	*	*	*	*	4.0	5.0	6.4
Central Coast										
Roe Catch	10.8	14.0	0	0.5	2.6	7.0	5.7	7.2	5.2	2.8
Roe Quota	11.8	14.5	8.2	*	*	*	*	6.6	4.1	2.3
Strait of Georgia										
Roe Catch	12.6	11.5	6.8	3.3	7.1	8.9	16.4	10.2	6.2	0.2*
Roe Quota	10.9	11.1	16.3	13.6	9.1	11.8	11.7	11.6	4.7	0
West Coast Vancouver Island										
Roe Catch	30.1	20.0	19.3	4.5	8.8	6.1	8.7	6.7	0.2**	0.2*
Roe Quota	33.6	27.2	18.8	13.6	10.0	9.1	4.5	4.5	0	0
Total Coast										
Roe Catch	73.6	63.1	37.3	14.4	26.3	27.5	38.9	32.6	24.4	15.1
Roe Quota	72.6	74.6	53.8	31.7	27.3	31.8	28.0	31.3	18.9	12.5

*North of Cape Caution the quota for 1980, 1981, 1982, and 1983 was 4.5, 8.2, 10.9, and 11.8, respectively.

**Charter boat removals.

Catches ('000 tonnes) of other herring fisheries, such as winter food and bait, spawn-on-kelp, commercial bait, sports bait, personal use, charity and aquarium since the 1981-82 season are shown below:

	1981-82	1982-83	1983-84	1984-85	1985-86
Other herring fisheries	12.5	5.4	4.8	4.9	3.3

Age Composition

Queen Charlotte Islands

The seine catch in 1986 was dominated by 4 and 5 year-old herring, namely the 1982 (22%) and 1981 (40%) year-classes. There was also a substantial contribution of the strong 1977 year-class (19%), which are now 9 year-olds.

Prince Rupert District

The seine catch in 1986 was dominated by 5 year-old herring of the 1981 year-class (46%). The 3 year-olds made up 14% which is below the 14-yr average of 20% for the roe fishery period.

Central Coast

The seine catch in 1986 was dominated by 3 and 4 year-old herring, namely the 1983 (16%) and 1982 (40%) year-classes. This contribution of the 1982 year-class was the highest since 1981 (51%).

Strait of Georgia

North - The samples from the 1986 charter program were dominated by 3 and 4 year-old herring, namely the 1983 (55%) and 1982 (25%) year-classes. This high contribution of the 1983 year class is above the 14-yr average (41%) for the roe fishery period.

South - The charter samples consisted predominately of 3 year-olds of the 1982 (58%) year-class with 19% and 15% 2 year-olds and 4 year-olds, respectively. The contribution by the 1983 year-class is the highest for the roe fishery period.

West Coast Vancouver Island

South - The samples from the 1986 charter program were dominated by 3 and 4 year-old herring, namely the 1983 (49%) and 1982 (27%) year-classes. The contribution of the 1983 year class is comparable to the 1982 year-class (50%) the previous year.

North - The charter samples consisted predominately of 3 and 4 year-old herring of the 1983 (47%) and 1982 (44%) year-classes. The contribution of the 1983 year-class is above the average (35%) for the roe fishery period.

Stock Status in 1986

Herring abundance, coastwide, increased substantially in 1986. This increase resulted from above average recruitment to the south coast herring stocks.

In 1986, like 1985, two analytical assessment methods were used to estimate current stock conditions and forecast 1987 abundance: (1) an escapement model; and (2) an age-structured model. The methods used estimate current stock conditions, and future levels of recruitment. Both methods use a 36-year time series of catch, spawn deposition, and age-structure information. The following discussion of stock trends is based on the weighted average escapement estimate of both assessment methods.

North Coast Stocks

The Queen Charlotte Islands and the Central Coast stocks have been in a state of decline since 1982. The decline, however, is less severe in the Central Coast stock (Fig. 1). Both stocks reached historically high levels in the early 1980s because of the extraordinarily large 1977 year class, which appeared as 3-year-old fish in 1980. Since then there has been a seven year unbroken run of below average recruitment to the Queen Charlotte Island stock. There is great concern about the current status of this stock because this is the longest run of poor recruitment since 1951, and the stock is clearly approaching a level where adequate spawning escapement must be ensured. The estimated spawning biomass in 1986 is 15,100 tonnes. If recruitment to the Queen Charlotte Islands stock is below average again in 1987, then appropriate steps may have to be taken to conserve the spawning stock in 1988.

The 1982 year class, which recruited to the Central Coast stock this spring, was of average strength and halted the stock decline. The estimated spawning biomass of the Central Coast migratory stock in 1986 is 19,200 tonnes.

The situation in the Prince Rupert District is different. This stock increased steadily through the late 1970s and the spawning biomass has remained at high levels over the past four years. The weighted escapement estimate for 1986 is 26,800 tonnes.

In the Hecate Strait area there is an established interaction between abundance of herring and one of their predators, Pacific cod. This interaction may have had an effect on northern herring abundance. Based on catch information, it appears that Pacific cod abundance has declined in Hecate Strait since 1983. A decline in herring predators might account for the high herring abundance in the Prince Rupert area, but this would not explain the decline in the Queen Charlotte Islands stock. Research on the biological basis for recruitment variability in the northern herring stocks is continuing.

South Coast Stocks

The south coast herring stocks (we currently recognize four for management purposes) declined steadily between 1980 and 1985 because of six consecutive years of below-average recruitment. Based on recent above-normal ocean temperatures and the high hake abundance off the west coast of Vancouver Island poor recruitment was anticipated for 1986. This forecast turned out to be wrong. Recruitment to the west coast of Vancouver Island stocks was slightly above average. Similarly, in the Strait of Georgia recruitment was average in the southern stock and well above average in the northern stock. The combination of an improvement in recruitment and closure of the south coast fisheries caused a sharp increase in 1986 stock levels. The 1986 spawning biomass was above the long-term average for all south coast stocks, except the southern Strait of Georgia stock (Fig. 2). The estimated biomass of spawners for the northern and southern Strait of Georgia stocks was 38,700 tonnes and 8,200 tonnes, respectively, for a total of 46,900 tonnes. Spawning biomass in the northern stock more than doubled from 1985 while that of the

southern stock increased by 60%. The increase in stock abundance on the west coast of Vancouver Island was of similar magnitude. The estimate of 30,400 tonnes of spawners for the southern west coast stock represents a 43% increase over 1985 levels while the estimate of 11,700 tonnes for the northern stock is more than double that of the previous year.

The substantial increase of south coast stocks in 1986 reflects the fact that spawning biomass is very sensitive to recruitment when the stocks are low. It is very difficult to forecast recruitment accurately because so many biological and environmental factors are involved. The forecasts will improve when some of the key factors affecting the success and failure of herring year-classes are better understood. To this end, a major long-term research project was initiated in 1985 on La Perouse Bank to investigate effects of oceanographic conditions and offshore predators on herring recruitment.

Recruitment Forecasting and Prognosis for 1987

Catch levels at 20% of the "best" forecasts of the 1987 pre-fishery stock biomass are recommended for those stocks that are well above CUTOFF levels. The 20% harvest rate is based on an analysis of stock dynamics which indicates this level will stabilize both catch and spawning biomass while foregoing minimal yield over the long term. While a fixed escapement policy would provide the theoretical optimal solution, that is, highest yields and stock stability, this policy is not attainable at the operational level. For stocks that are marginally above CUTOFF the following catches are recommended:

Catch = Weighted Run - CUTOFF

This will provide for smaller fisheries for areas where the 20% harvest rate would bring the escapement down to dangerously low levels.

CUTOFF levels are established at one-forth of the unfished equilibrium biomass. The unfished equilibria were estimated using computer simulations. For the seven areas on the coast, the following CUTOFF levels were estimated:

Queen Charlotte Islands	13,100 tonnes
Prince Rupert District	8,900 tonnes
Central Coast	11,100 tonnes
Strait of Georgia-north	14,600 tonnes
Strait of Georgia-south	6,200 tonnes
W.C. Vancouver Is.-south	15,400 tonnes
W.C. Vancouver Is.-north	6,000 tonnes

The forecasts of recruitment, the corresponding 1987 weighted runs, and recommended catches ('000 tonnes) are shown below:

Area	Recruitment	1987 Weighted run	Recommended catch
Queen Charlotte Islands	poor-average	15.32	2.22
Prince Rupert District	average-good	32.05	6.41
Central Coast	average	23.00	4.60
Strait of Georgia			
North	average	42.95	8.59
South	average	10.00	2.00
Total		52.95	10.59
West Coast Vancouver Island			
South	average	33.70	6.74
North	average	14.62	2.92
Total		48.32	9.66
Total Coast		171.64	33.48

For the Queen Charlotte Islands the forecast stock size of 15,320 tonnes is only marginally above the CUTOFF of 13,100 tonnes. A catch of no greater than 2,220 tonnes is recommended; this is determined by taking the difference between the forecast run and the CUTOFF (see above). Because this stock is approaching the minimum spawning level the prognosis for fisheries in 1988 is poor unless recruitment of 3 yr-old fish next year is at least average, or better.

For the Prince Rupert District, assuming average to good recruitment, a pre-fishery stock size of 32,050 tonnes is forecast. This yields a recommended catch of 6,410 tonnes. The forecast run to the central coast, based on a predicted average recruitment, is 23,000 tonnes. As this stock is still well above the CUTOFF level, a 20% harvest rate yields a recommended catch of 4,600 tonnes.

Forecasts using time-series analysis predict average recruitment in 1987 for all south coast herring stocks. This, combined with reasonable estimates of returning adults, means that all southern stocks are predicted to be well above CUTOFF levels in 1987. The forecast runs for the Strait of Georgia are 42,950 tonnes for the northern stock and 10,000 tonnes for the southern stock. These stock predictions yield recommended catches of 8,590 tonnes and 2,000 tonnes for the northern and southern stocks, respectively. The forecast for the southern west coast of Vancouver Island is 33,700 tonnes with a recommended catch of 6,740 tonnes. For the northern west coast the forecast stock size is 14,620 tonnes yielding a recommended catch of 2,920 tonnes.

The catch levels recommended here are based solely on biological considerations. PSARC recognizes that management of the various fisheries has practical constraints other than the biological considerations. Furthermore, there often are economic factors which are not considered when making

biological recommendations. Thus, the quotas adopted by DFO managers may differ from those recommended herein. It should also be noted that the catch levels recommended here include all fisheries. Catches from food, bait, and special fisheries must be subtracted from the recommended catch levels to determine roe herring quotas.

Reviewers Comments and Research Recommendations

The herring assessment procedure is basically sound. The framework for advice on herring catch levels is well developed and appropriate for management of the species on a sustained basis. The 20% target catch level in combination with the CUTOFF is appropriate for stabilizing stock biomass and catch without undue loss of potential yield.

To improve on the current assessment procedure PSARC makes the following research recommendations:

(i) Conduct simulation studies to examine the sensitivity of the age-structured model to deviations from model assumptions and the effects of the penalty weights.

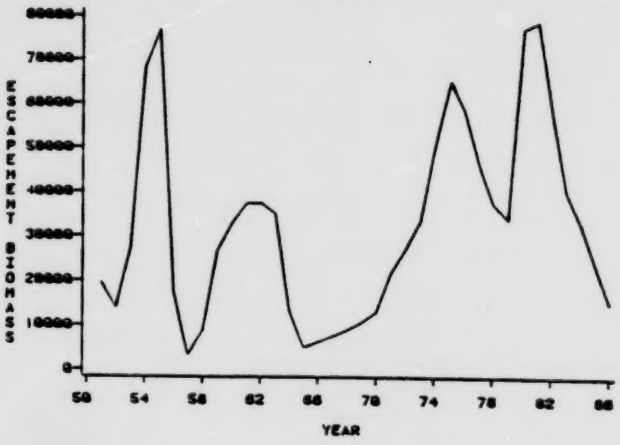
(ii) For both modelling approaches used for herring stock assessment, confidence intervals of model parameters and forecasted biomass should be calculated.

(iii) Conduct field studies to investigate egg loss over the incubation period so that escapement estimates from spawn survey data can be adjusted accordingly.

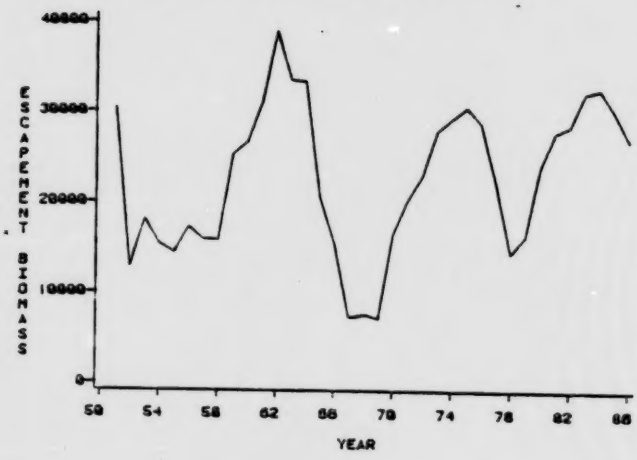
(iv) To enhance forecasts of recruiting herring stock sizes surveys of the relative abundance of juveniles should be conducted.

(v) Continuation of studies on herring recruitment mechanisms to determine major factors determining year-class strength.

QUEEN CHARLOTTE ISLANDS



PRINCE RUPERT DISTRICT



CENTRAL COAST

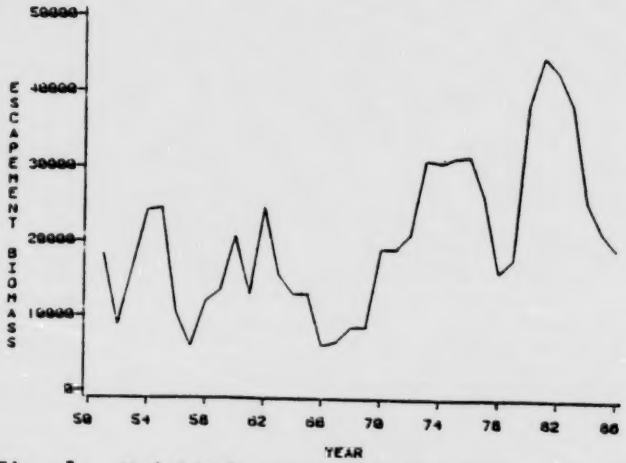


Fig. 1. Weighted escapement estimates (tonnes) for northern stock groupings, 1951-1986.

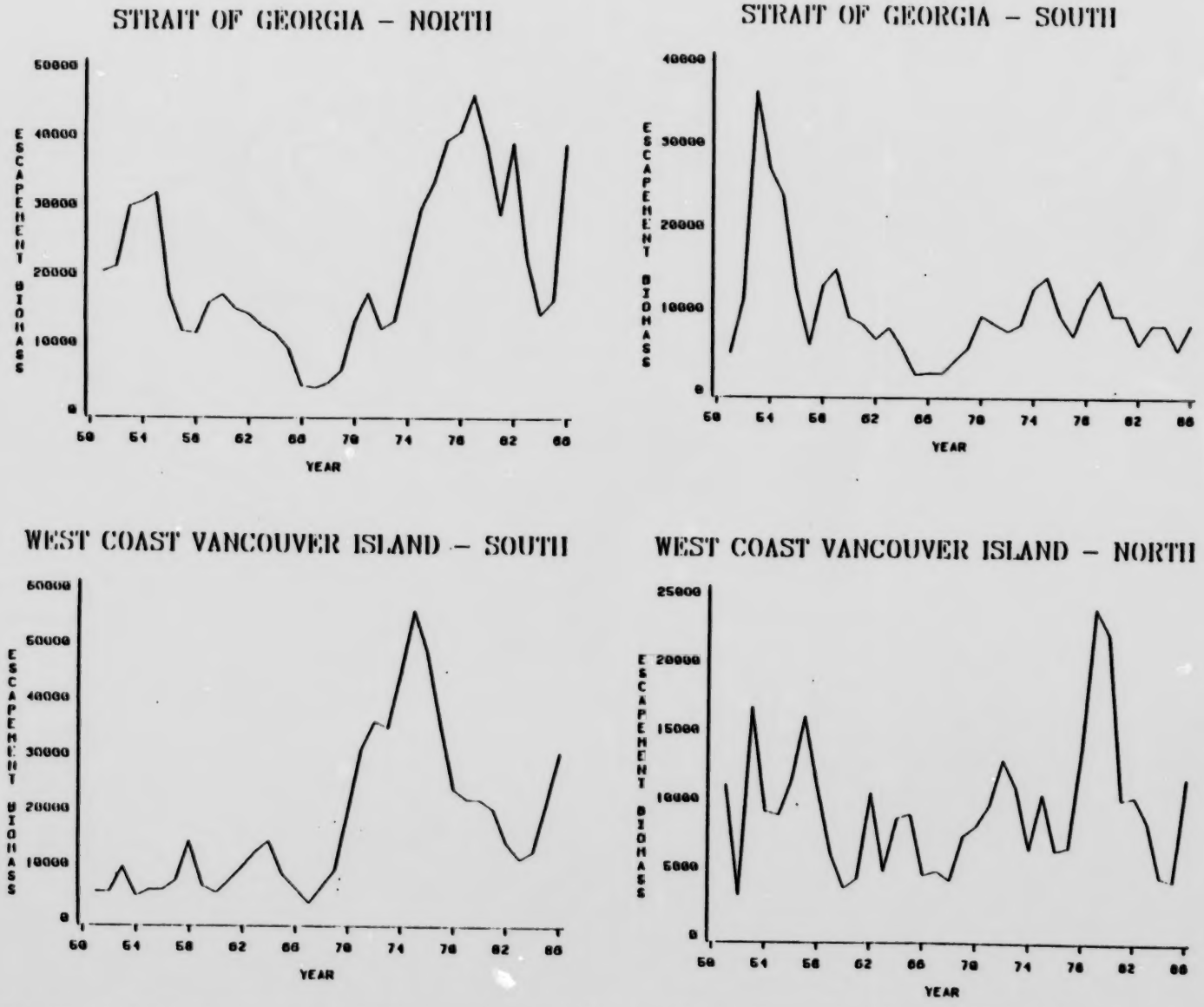

STRAIT OF GEORGIA – NORTH
STRAIT OF GEORGIA – SOUTH
WEST COAST VANCOUVER ISLAND – SOUTH
WEST COAST VANCOUVER ISLAND – NORTH
ESCAPEMENT BIOMASS
YEAR

Fig. 2. Weighted escapement estimates (tonnes) for southern stock groupings, 1951-1986.

Pacific Stock Assessment
Review Committee

Steering Committee Review of
PSARC Advisory Document 86-1

Advice on the Management of Pacific Herring Stocks in 1987

J. Schweigert, Chairman, Herring Subcommittee, presented the Herring Advisory Document.

The steering committee reviewed the Herring report and suggested future documents should include:

i) a paragraph clearly defining management policy.

ii) a paragraph identifying weak links (e.g. spawn enumeration) and flag fisheries concerns.

iii) address long-term biological objectives and harvest potentials.

iv) attach list of working papers.

The report was APPROVED and the recommendations endorsed.

Approved for release by Fisheries Resource Management Executive Committee

Pacific Stock Assessment
Review Committee

PSARC Advisory Document 86-2

Advice on the Management of Pacific Groundfish Stocks in 1987

This PSARC Advisory Document contains brief summaries of stock conditions of the important groundfish stocks, and recommendations for their management to the Offshore Division of the Field Services Branch. The report is based on the more extensive report prepared by the staff of the Groundfish Section of the Fisheries Research Branch, located at the Pacific Biological Station, Nanaimo, British Columbia, Canada V9R 5K6.

Department biologists begin their assessments in the spring of the year using a multi-year data base for fishery statistics and biological research. A variety of assessment models are used including several sequential analysis models, age-independent surplus production models, yield-per-recruit, and linear model. Assessments are completed in August after review by a Committee of D.F.O. Groundfish scientists. Review may also incorporate outside investigators (government or non-government), where desired by the D.F.O. Research Branch (F.R.B.). Assessments are then reviewed by the D.F.O. Pacific Stock Assessment Review Committee and recommended yield options are collated and sent to the Offshore Division of Fisheries Branch for consideration.

A number of levels of yield options are presented. All may not be appropriate to apply to a particular species or stock. The seven yield options are: (i) zero yield; (ii) rebuilding harvest; (iii) sustainable; (iv) conservative-sustainable; (v) risk-sustainable; (vi) non-sustainable and (vii) unrestricted yield.

(i) Zero yield

This option could be entertained under situations of known and severe stock depletion, or where particular areas may represent necessary refuges for the fish. Additional ecological considerations might include situations where the subject stock acts as a predator on a less desirable species, and the objective is to maximize predation.

(ii) Rebuilding yield

Under this option the probability of overfishing is minimized while that of rehabilitating depleted stocks is increased. With the exception of option (i), this approach will incur the lowest risk of deleterious effects on stock biomass and dynamics. It is also true that it represents a lower yield than could be taken out of the stock on a sustainable basis. The most common application of this option is for stock rebuilding although for rockfish stocks this should be the approach to developing fisheries, because of the detection, response and corrective time frames (10-20 y) for rockfish species.

(iii) Sustainable yield

This option provides some opportunity to maintain stocks at existing levels. In many ways this is the least certain of the options available since it entrains many assumptions about the behaviour of stocks in response to fishing and biological processes. This option should be taken to mean that the probabilities of either decline or increase in yield (biomass) are approximately equal. The term "sustainable" should be understood in its broad sense, i.e. that the stock will oscillate around the expected level as a result of oscillation in recruitment, rather than be maintained at a fixed level. The amplitude and frequency of these oscillations may vary considerably among and within stocks at different levels of biomass. In the simplest terms, this is our best estimate of the highest yield at existing stock levels.

(iv) Conservative-sustainable

Like the Sustainable Option this is an estimate of the tonnage that can be caught during the year and leave enough of the biomass for the stock to replenish itself through reproduction and body growth. However, data are often not as complete as should be for calculation of a single, firm estimate of the true value of the sustainable yield. When there is a high degree of uncertainty about the estimate, a cautious approach to setting the catch limits should be taken. The cautious or conservative estimate is often set simply as 50% or 75% of the calculated sustainable yield, depending on the biologist's understanding of the firmness of the estimate.

(v) Risk-sustainable yield

This catch limit has some small chance of being a sustainable yield. The estimate is at the other end of the range from the Conservative-sustainable yield, and is above the Sustainable yield estimate. The level is often set simply as 25% or 50% higher than the sustainable yield value. Sometimes a central value for the sustainable yield is not given, only the Conservative and Risk levels. Risk levels should only be selected to provide relief from a specific case of economic hardship, and conscious recognition be made that decreases to sustainable levels in the near future might be the result of selecting this option.

(vi) Non-sustainable yield

While the sustainable option is derived from the biological properties of the species and stock composition, the non-sustainable level is largely an economic and management concept. The benefits of increased yield over the short-term must be weighed against the lowered future yields resulting from overfishing. Employment of this option implies either experimental or non-biological management, since stock declines are highly probable with such a policy in effect over a significant part of the average life of a population cohort. This option might be considered when:

socio/economic conditions require short-term yields in excess of sustainable harvest; experiments concerning well-defined and disparate exploitation rates are necessary; or, management policy requires sequential, pulsed fishing on several stocks.

This option requires that management will have to shift to a conservative policy to offset deleterious effects prior to major and irreversible stocks changes. Thus, this option either guarantees a pulsed exploitation pattern if the stock is to be maintained at the most productive level, or accepts short-term gains over long-term productivity.

The hazard associated with this option will vary with the biological characters of the target stocks. In particular, the residence time of a cohort in the vulnerable stock will be a key determinant in the time for detection and response. Where residency is long, higher than sustainable yields may be maintained over several years in spite of strongly deleterious, yet undetected effects on subsequent cohorts. Conversely, a short residency may permit more rapid detection of adverse effects although incremental increases in quotas should be small if uncertainty about effects if high.

(vii) Unlimited yield

Few conditions would call for consideration of this option. Depletion of stocks and elimination of fisheries when harvests are uncontrolled are well documented throughout the world. However, this option might be considered: for experimental purposes; for stock eradication (in the case of competing species); or for economic returns where the loss of a particular stock does not outweigh the chaotic effects that lowered yield would create in the industry.

Canadian views on current stock condition and abundance trends for groundfish species/species groups on the west coast of Canada are presented below:

Species or species group	TAC (1,000 t)	Current stock condition
Lingcod	0.900	average
Pacific ocean perch	2.55-3.80 (cons.-non sust.)[a]	low to average
Other rockfish	2.40-6.65 (cons.-non sust.)	average
Sablefish	4-5 (cons.-non sust.)	good
Pollock	2.5-[b] (cons.)	average
Pacific cod	1.7-[b]	low
Flatfish	-[c]	average

[a]TAC range is from conservative to non-sustainable yield options.
[b]No TAC recommended for some areas.
[c]Three species managed by mixture of area quotas and trip limits.

The recommendations for west coast groundfish for 1987 are summarized below:

Area	Species	Management options
4B	Lingcod	1. Continue winter fishing closure Nov. 15-Apr. 15. 2. Introduce minimum size limit of 58 cm for sport-caught lingcod to protect young.
3C	Lingcod	1. Conservative-sustainable: 900 t quota 10,000 lb trip limit after 75% of quota taken. 2. Risk-sustainable: 1400 t quota, 20,000 lb/trip after 75% of quota taken.
3D, 5A, 5B, 5C, 5D, 5E	Lingcod	No options proposed.
4B	Pacific cod	No options proposed.
3C/3D	Pacific cod	Close Amphitrite Bank and safety margin to all trawling.
5A/5B	Pacific cod	No options proposed.
5C/5D	Pacific cod	1. Conservative-sustainable 900 t annual quota (half option 2) 2. Risk-sustainable 1800 t annual quota. 3. Risk-sustainable. No quota, fishing effort self-regulating.
5E	Pacific cod	No options proposed.
4B	Flatfish	No options proposed.
3C/D	Flatfish	No options proposed.

Area	Species	Management options
5A/5B	Rock sole	1. Sustainable: 400 t (30,000 lb trip limit) 2. Risk-sustainable: no quota, fishing effort self-regulating
5C/5D	English sole	1. Conservative-sustainable: 400 t quota 2. Sustainable: 600 t quota (trip limit 20,000 lb) 3. Increase yield, codend mesh size regulated 5" internal measure) 4. Risk-sustainable: no quota, fishing effort self-regulating.
	Rock sole	1. Conservative-sustainable: area closure for 5D 2. Sustainable: 30,000 lb trip limit 3. Risk-sustainable: no trip limit, fishing effort self-regulating.
	Arrowtooth flounder	1. Sustainable: 4000 t quota 2. Risk-sustainable: 5000 t quota
5C/5D/5E	Dover sole	1. Sustainable: 800 t quota, 20,000 lb/trip permitted <u>after</u> the quota is reached. 2. Risk-sustainable : 1000 t quota 20,000 lb/trip permitted after the quota is reached.
Coastwide	Sablefish	1. Conservative-sustainable: 4100 t quota 2. Risk-sustainable: 4500 t quota
4B	Walleye pollock	1. Conservative-sustainable: 2500 t quota 2. Risk-sustainable: 5400 t quota
3C/3D	Walleye pollock	Options not proposed.
5A/5B	Walleye pollock	Options not proposed.

Area	Species	Management options
5C/5D	Walleye pollock	Open fishing option proposed
5E	Walleye pollock	Options not proposed
4B	Pacific hake	1. Conservative-sustainable: 10,000 t quota 2. Risk-sustainable: 15,000 t quota
3C	Pacific hake	Yield options to be presented at a later date when all current biological information is collated in the joint Canada-U.S. assessment algorithm.
4B	Dogfish	1. Pulse fishing--variable annual quota, see text. 2. Conservative-sustainable--2000 t annual quota 3. Risk-sustainable--3000 t annual quota
Coastwide (not including 4B)	Dogfish	1. Pulse fishing--variable annual quota until non-nuisance abundance reached. 2. Conservative-sustainable: 15,000 t 3. Risk-sustainable: 25,000 t
Coastwide	Pacific ocean perch plus yellowmouth rockfish	1. Conservative-rebuilding: 2500 t 2. Sustainable 3100 t 3. Non-sustainable 3900 t
Coastwide	Rougheye rockfish	1. Conservative-sustainable: 100 t 2. Sustainable 250 t 3. Non-sustainable 400 t
3C	Pacific ocean perch	1. Conservative-sustainable 0 t 2. Sustainable 100 t 3. Non-sustainable 200 t Implementation of a non-directed, incidental only fishery should be considered.

Area	Species	Management options	
3D	Pacific ocean perch	1. Conservative-sustainable	250 t
		2. Sustainable	350 t
		3. Non-sustainable	500 t
3D/5A	Yellowmouth	1. Conservative-sustainable	200 t
		2. Sustainable	350 t
		3. Non-sustainable	500 t
5A/5B	Pacific ocean perch	1. Conservative-rebuilding	400 t
		2. Sustainable	500 t
		3. Non-sustainable	650 t
5C/5D	Pacific ocean perch	1. Conservative-sustainable	1700 t
		2. Sustainable	2000 t
		3. Non-sustainable	2500 t
5C/5D	Yellowmouth	1. Conservative-sustainable	200 t
		2. Sustainable	250 t
		3. Non-sustainable	300 t
5C/5D	Grouped Pacific ocean perch & yellowmouth	1. Conservative-sustainable	1900 t
		2. Sustainable	2250 t
		3. Non-sustainable	2800 t
5E-S	Pacific ocean perch	1. Conservative-sustainable	400 t
		2. Sustainable	600 t
		3. Non-sustainable	1000 t
5E-S	Yellowmouth	1. Conservative-sustainable	400 t
		2. Sustainable	600 t
		3. Non-sustainable	1000 t
5E-S	Rougheye	1. Conservative-sustainable	100 t
		2. Sustainable	250 t
		3. Non-sustainable	500 t

Area	Species	Management options
5E-S	Grouped slope rockfish	January-June 1. Conservative-sustainable-- 300 t 2. Sustainable 500 t 3. Non-sustainable 900 t September-December 1. Conservative-sustainable-- 600 t 2. Sustainable 900 t 3. Non-sustainable 1300 t
5E-N		Experimental fishing: We recommend continuation of the experimental open-fishery area north of 54°00'N and west of 133°00'W until the end of 1987.

Lingcod

Strait of Georgia

Stock condition - There is no estimate of current stock productivity due to the lack of a suitable time-series of sports fisheries data. The long-term decline in the commercial handline fishery indicates stocks are now at low levels. The reason for the decline in stock size is not known, however, over-fishing is suspected.

In an attempt to rebuild stocks, the winter fishing closure was extended in 1979 from December - March to November 15 - April 14 to more suitably cover the pre-spawning aggregation, spawning and nesting periods. Data are being collected to monitor year-class strengths. Results of larval and juvenile surveys and tagging studies indicate that the abundance of young lingcod has been increasing. However, there is no evidence that an increase in the size of the adult stock components has occurred.

As reported in the 1984 and 1985 assessments, tag recapture data and biological samples collected in 1983 indicate that a significant proportion of the sports landings consist of immature fish.

Recommendations - Management recommendations remain unchanged from 1986. Specifically, it is recommended that the present lingcod fishing closure be continued. A minimum size limit for the sports fishery similar to the size limit for the commercial fishery is also recommended.

West Coast Vancouver Island

Stock condition - The large decline in LPUE in Area 3C between 1985 and 1986 indicates that stocks have declined substantially. Stocks may have been over-fished in 1985. Estimates of the long-term average sustainable

yield using Deriso's delay-difference model ranged from 900-1400 t/yr for Area 3C. Landings in 1985 were considerably higher.

The low landings from Area 3D in 1985 compared to estimates of average sustainable yield 460-510 t/yr) and the slight decline in LPUE between 1985 and 1986 do not warrant concern for the Area 3D stock.

Recommendations - There is concern that high levels of fishing effort in Area 3C in 1985 may have resulted in over-fishing. The high level of fishing effort in Area 3C in 1985 was, in part, due to a lessening of market limits that in the past have created a buffer against over-fishing. It is recommended the following yield options are for Area 3C in view of the large decline in LPUE and the apparent higher demand for lingcod:

1) A conservative quota of 900 t to maintain landings at the lower range of long-term yield. The catch should be monitored and if 75% of the quota is taken we suggest a 10,000 lb trip limit be imposed to ensure an equal distribution of landings during the rest of the year.

2) A higher risk quota of 1400 t to maintain landings at the upper range of long-term yield. The catch should be monitored and if 75% of the quota is taken we suggest a 20,000 lb trip limit be imposed to ensure an equal distribution of landings during the rest of the year.

There is a lesser concern about the Area 3D stock. The estimate of long-term sustainable yield suggests stocks have generally been under-exploited. Therefore a change in the management strategy for Area 3D is not recommended.

Queen Charlotte Sound

Stock condition - The increase in LPUE and corresponding decline in trawling effort between 1985 and 1986 (to July 1) in Area 5A suggests that stocks are not over-exploited and are generally in good shape. The decline in LPUE with a corresponding increase in trawling effort between 1985 and 1986 in Area 5B suggests that stocks in that area have declined.

From the last comprehensive assessment, estimates of the average long-term sustainable yields expected from Queen Charlotte Sound were 450 t/yr in Area 5A and 640-730 t/yr in Area 5B.

Recommendations - Estimates of long-term sustainable yields for Queen Charlotte Sound indicate stocks have not been fully utilized during most years since 1956. It is recommended not to alter management strategies in Area 5A or Area 5B.

Pacific cod

Strait of Georgia (Area 4B)

Stock condition - Based on standardized landing statistics and mortality rates, the four principal Pacific cod stocks exploited in Area 4B

appear to be unaffected by the current fishery. The substantial decline in, and prolonged low level of, landings from Nanoose has been attributed to diversion of cod elsewhere, cause unknown. The rise and fall in cod landings from MSA 19during 1974-85 has been attributed to the anomalous behaviour of adult herring inbound to spawn in Area 4B. The general decline in cod landings from Area 4B since 1980 is a coastwide phenomenon, largely attributed to non-fishery-related factors.

Recommendations - No change in the current regulations is recommended at this time. The available evidence suggests that recruitment overfishing is not a problem, and current minimum mesh-size is reasonably satisfactory with respect to optimizing catch profitability.

West Coast of Vancouver Island (Areas 3C and 3D)

Condition of the stock - Landings and LPUEs have remained at a relatively low level during the past 4 or 5 years, and some concern over possible recruitment overfishing is justified. However, the recent decline in cod abundance is a coastwide phenomenon, applicable equally to stocks with widely disparate exploitation histories. A hopeful sign is the appearance coastwide (based on reports of trawl captains), of the relatively strong 1985 year-class, which will begin recruiting to the fishery during the spring of 1987. Absolute abundance of this year-class is unknown, and hence we cannot predict the amount of increase in abundance of marketable cod in 1987.

Recommendation - Because of the continued low abundance of mature fish it has to be recommended that Amphitrite Bank, and a safe margin around it, be closed to all trawling during January, February, and March, 1987. The closure is to protect cod during spawning, since they are particularly vulnerable to trawling on Amphitrite Bank during the spawning season. Evidence, that a fishery there during spawning could remove enough of the concentrated spawners to interfere with stock recovery, was presented in 1985.

Queen Charlotte Sound (Areas 5A and 5B)

Condition of the stock - In 1985 the LPUE index of abundance continued to be low, 62 kg/h, indicating a scarcity of marketable fish. In better years, for example 1978 and 1979, the index was as high as 258 kg/hr and 276 kg/hr. While a new assessment has not been carried out, the 1984 assessment indicated there was little danger of recruitment overfishing because of extensive, rough bottom refuges from trawling.

Recommendation - No recommendation is made for the fishery in 5A/5B.

Hecate Strait (Areas 5C and 5D)

Stock conditions - The index of stock abundance is standardized landings per unit effort (LPUE), during April-September. Like total landings, LPUE has decreased steadily since 1983: 400 kg/h, 1983-84; 322 kg/h, 1984-85; 148 kg/h, 1985-86. Research trawling Hecate Strait in June and October 1985

and February 1986, as well as commercial fishermen's reports indicate that a moderately strong 1985 year-class is present on the grounds.

Recommendations - (a) Conservative sustainable yield-option: 900 t catch limit; (b) Risk sustainable yield-option 1: 1800 t catch limit; (c)Risk sustainable yield-option 2: No quota, fishing effort self-regulating. Recommendations this year are the same as last year. The first risk yield option is based on the observation that during the previous periods when abundance was as low as at present, (1960-63, and 1969-72), landings averaging 1800 t did not interfere with the recovery of the stock. The second risk option was formulated on the basis that fishing effort has in the past been tied to the abundance of cod, so that less cod meant less effort and proportionately lower catch. The managers selected the risk option last year. The resulting catch in the 1984-85 cod year turned out to be 1718 t, indicating that self-regulation occurred without a closure.

There is some risk in choosing the second or third options for two reasons: (1) the spawning cod stock has never been recorded to be so low for so long a period (since 1977), raising the possibility that the potential for rapid recovery is no longer as strong as it once was. (2) the relative abundance index (LPUE) is not as reliable when the fish are not abundant. Hence there is no certainty of true stock abundance. Statistical testing of the effect of stock size on the production of young is correspondingly uncertain.

Flatfish

West Coast of Vancouver Island

No new assessments have been carried out for flatfish species in this region and yield options remain the same as those in 1985.

Queen Charlotte Sound

Area 5A Rock Sole

Stock condition - The landings for 1986 through July 11 are 12 t, compared with 42 t over the same period in 1985. Catch and effort are particularly low in 1985-86 compared to earlier years (1979-82). This reflects the lack of emphasis of a shallow water fishery in Area 5A since the early 1980s due to a scarcity of Pacific cod. Fishing effort in Area 5A is currently being directed at the more lucrative rockfish fishery. Length-frequency data for 1985 indicates that recruitment is at low levels.

Recommendations - Sustainable yield option: A yield of 200 t was sustained during the period 1972-85 (LPUEs for similar levels of effort are equivalent). The 30,000 lb trip limit currently in effect for Queen Charlotte Sound is consistent with this option. Analysis of landings for rock sole in Area 5A by trip category indicated that if rock sole trips >30,000 lb were eliminated, landings were never greater than 200 t for any year from 1956-85.

Non-sustainable option: Yields of >400 t in the past have been associated with declines in LPUE and possible declines in abundance for the stock.

Area 5B Rock Sole

Stock condition - Landings of rock sole in Area 5B to July 11, 1986, are 62 t. This compares to 48 t landed during the same period for 1985. There was a slight increase in LPUE in 1985 and a significant decline in effort compared to 1983-84. There has been little trend in LPUE since 1981 for the Area 5B stock of rock sole. This is interpreted as being due to a stable stock size over that time period.

Length-frequency data for the stock indicates a low level of recruitment in 1985. Samples collected thus far in 1986 indicate no significant increase in recruitment to the fishery in 1986 over 1985.

Recommendations - Sustainable yield option: An average yield of 200 t was taken annually during the period 1981-85. This level is recommended as a sustainable yield at the present time. The 30,000 lb trip limit currently in effect for Queen Charlotte Island is consistent with this option.

Hecate Strait

Area 5C Rock Sole

Stock condition - Length-frequency samples collected thus far in 1986 indicate no significant increase in recruitment to the fishery over 1985. Recruitment for the 5C stock is, therefore, still considered to be at low levels as shown in the previous analysis. With recruitment at low levels, potential yield for the stock is considered to be low at the present time.

Recommendations - Sustainable yield option: With the current low recruitment mode the 30,000 lb landing limit for rock sole in Hecate Strait should be retained. This is consistent with keeping effort (and fishing mortality) at low levels to protect the stock from possible recruitment overfishing. The sustainable yield level at present is estimated at 100 t, equivalent to the average yield from 1981-85, a period of stable LPUE.

Risk yield option: To date there is no direct evidence that either the Area closure in 5C from (1980-83) or the 30,000 lb trip limit have had any effect on recruitment for the species. Therefore removal of the 30,000 lb landing limit can be considered. This option is not recommended.

Area 5D Rock Sole

Stock condition - The LPUE index for rock sole indicates that Area 5D stock is at its lowest level in 1985 since monitoring of this fishery began. Recruitment surveys of Hecate Strait for rock sole as well as port sample length-frequency data indicate extremely low levels of recruitment for this stock in recent years. The primary question for management is to what degree has the fishery been responsible for the decline in abundance of this stock. Results from analysis of tag recoveries for rock sole in Hecate Strait

indicate a significant increase in the natural mortality rate for this species in the early 1980s.

The $F_{0.1}$ fishing level for rock sole was determined. $F_{0.1}$ for rock sole in Area 5D was calculated at 0.44. The average fishing mortality rate for rock sole as determined by cohort analysis results indicates that the fishing rate for rock sole in Area 5D was higher than $F_{0.1}$ in the mid- to late-1960s and the mid-1970s. This combined with unfavourable ocean temperatures for recruitment was well as increases in the natural mortality rate in the early 1980s could have significantly reduced the rock sole stock size in Area 5D. The present fishing rate for rock sole in Area 5D is probably below $F_{0.1}$ levels.

Length-frequency data for 1986 indicates no significant increase in recruitment for the Area 5D stock.

Recommendations - Conservation yield options: With effective fishing effort for rock sole in Area 5D at low levels at present, a closure of Area 5D would be the only option to produce a significant decrease in the fishing rate for rock sole. This is not recommended for the following reasons: (1) ocean temperatures play a significant role in determining production success for rock sole in Area 5D and at present, ocean temperatures are not favourable for recruitment for rock sole; (2) fishery production for English sole, Dover sole, and Pacific cod contribute to the major fishery production, and this production would cease under an area closure; (3) indications are that conditions other than fishery have limited the size of the rock sole population in Area 5D; and (4) Area closures in the past have had no effect on rock sole recruitment and subsequent abundance.

Sustainable yield option: The current fishing rate for rock sole in Area 5D is below $F_{0.1}$ calculated for the stock. The 1986 LPUE observation indicates that abundance of rock sole in Area 5D may again be increasing. The 30,000 lb trip limit in effect for rock sole in Area 5D will help to achieve this option.

Area 5D English Sole

Stock condition - The length-frequency anomaly calculated for 5D English sole females for 1985 indicates a significant increase in the proportion of younger fish (recruits) landed in 1985. Anomalies for recent years also indicate numbers of larger fish caught in the commercial fishery are declining.

$F_{0.1}$ was calculated at F-0.41 (assuming M=0.2) for the Area 5D English sole stock. The catchability coefficient for the stock was previously determined at q=.000183. Using the formula $F=qE_t$ with E_t=2681 hr (1985 effort), F=0.49 in 1985. If the trend in effort for 1986 continues, F levels in 1986 will be lower than 1985.

Recommendations - Sustainable yield option: The current yield for English sole in Area 5D 500-600 t) is sustainable. Current levels of fishing are equivalent to the $F_{0.1}$ level. A catch limitation is not recommended under present levels of fishing effort.

Conservative yield option: The decrease in the proportion of larger, older fish in commercial landings could be a sign of fishing up for the stock. A catch limit of 400 t annually (= 60-70% of sustainable yield) would increase survival of fish to older ages and be consistent with a stable age composition for the stock.

Increasing yield: Increases in production due to elimination of discards of juvenile English sole in Area 5D would effectively increase long-term yield up to 30% given the current age structure for the stock. A codend mesh-size of 5" (internal measure) would ensure optimum yield per recruit (optimum escapement for fish <35 cm) for English sole in area 5D.

Areas 5C, 5D, and 5E Dover Sole

Stock condition - $F_{0.1}$ calculated for 5C, D, E Dover sole was F=0.20. The current fishing rate for 5C, D, E Dover sole estimated from tagging data is F=0.15. The implication here ($F<F_{0.1}$) is that the stock is not being overfished at the present time.

Since 1976 LPUE for 5C, D, E Dover sole has shown no trend. This is taken as an indication of a stable stock size over this time period. The average yield from 1976-85 was = 740 t. Current yields appear to be sustainable for the 5C, D, E stock.

The estimate of MSY using Gulland's production analysis on standardized LPUE/effort data with k=3 is 837 t.

All three of the above analyses indicate that the 5C, D, E Dover sole stock is in stable condition, and that yields of 800 t annually are sustainable.

Sustainable yield option: 800 t - Equivalent to the average sustainable yield over the last 10 years and MSY from the Gulland analysis. Allow retention of incidental catches (20,000 lb) when 800 t quota is reached. After monitoring LPUE for 2-3 years at the 800 t harvest level a decision can be made regarding raising the quota to 1000 t.

Risk option: 1000 t - Increasing yield may be possible with F=0.15 at present and $F_{0.1}$-0.20. This option is not recommended until Dover sole LPUE has been monitored at the 800 t harvest level for a period of 2-3 years.

Arrowtooth Flounder

Stock condition - Using the 1980 arrowtooth flounder survey catch rates (stratified by area/depth) a biomass estimate of 52,700 t was obtained using the area swept by the net and a catching coefficient of 1. A second biomass estimate of 45,000 t was obtained using the 1984 G.B. REED Hecate Strait species assemblage survey data over a depth range of 30-80 fath. Using Gulland's relationship of $MSY=r(M)(B_0)$ estimates of MSY were calculated at 4000 t and 3400 t, respectively, for the above biomass estimates assuming r=0.5 and M=0.15. These are conservative figures, considering the fact that

the biomass estimates are almost certainly less than the arrowtooth virgin biomass in Hecate Strait, and that not all of the suitable habitat for arrowtooth was surveyed.

The arrowtooth flounder stock(s) in Hecate Strait is currently not being fully utilized. It is not yet known to what degree arrowtooth can be fished avoiding incidental catch of other species under catch limitations. Accordingly, unrestricted development of the arrowtooth fishery would be undesirable.

Recommendations - Sustainable yield option: At the present time catches of 4000 t annually (average of the two biomass estimates is 3700 t) are estimated to be sustainable. Catch limits are not recommended at the present time.

Risk yield option: Because of the uncertainties of the application of the Gulland formula and biomass estimates, a catch limit of 5000 t per year may be considered as a higher risk alternative to the sustainable option. Catch limits are not recommended at the present time.

Sablefish

Coastwide

Stock condition - LPUE continues to fluctuate over a wide range. The decrease in LPUE noted in 1986 is believed to be the result of a number of new vessels with inexperienced skippers entering the fishery in 1986. Vessels with more experienced skippers maintained higher LPUE's. Effort standardization is currently underway and will be available for future assessments.

The approach taken in this assessment is identical to that reported in the 1985 assessment. A forward simulation model was used to project sablefish biomass and yield from 1980 to 1995. The numbers at age used as the starting vector for the forward simulation were calculated using Virtual Population analysis (VPA).

All projections showed the same general trends in biomass and yield levels over time. Biomass increases sharply until 1985, and then decreases as the effects of the 1977 year class and above average year classes in 1979 and 1980, declines. The results indicate that yields should remain at a level close to that recommended for 1986. Any increase should be cautious in light of the error associated with the assessment techniques applied here. Until firm estimates of natural mortality are available, the estimates of number at age, alone, may be in error by a factor of two.

Recent analysis indicate that the 1981 and 1983 year classes may be of above average strength. If these year classes recruit to the fishery at the same strength as indicated by juvenile abundance indices, it is anticipated that yields will remain above the long-term average (3500 t) into the 1990s.

Recommendations -

Yield option		Yield (t)
Sustainable - low risk	-	4100 t
Sustainable - high risk	-	4500 t
Non-sustainable	-	> 4500 t

A low risk or conservative approach is recommended in view of the uncertainty associated with the VPA and the forward simulations. There exists a strong possibility that the high risk or non-sustainable options could interfere with the future yield for the fishery.

Pacific hake

Strait of Georgia

Stock condition - There have been no new analyses conducted for the 1987 assessments. Sustainable yields have been calculated using Gulland's formula $MSY = a(M)(B_0)$.

LPUE has increased substantially (95%) in 1986 from 4.448 t/hr in 1985 to 8.675 t/hr. Length frequencies collected in 1985 indicate little change in the size composition from the previous years. Modal sizes of hake ranged from 41-42 cm. Age composition data indicated that the 1978 year-class remains strong, contributing 28% to the catches.

Biomass estimates remain unchanged from those presented in the 1985 groundfish stock assessment.

Recommendations - Yield options for 1987 may be chosen from:

Yield option 1: Sustained yield - low risk 10,000 t
Yield option 2: Sustained yield - high risk 15,000 t
Yield option 3: Unlimited yield

Risk is a function of the range in possible values for biomass and natural mortality used in Gulland's formula for MSY. At catch levels near or above the 10,000 t level, the reproductive response of the stock to exploitation must be carefully monitored.

West coast of Vancouver Island

Stock condition - Biological data collected in 1985 indicate that there is no change in the size composition of the offshore hake stock in the Canadian zone. The fishery continued to be supported by a series of strong year-classes. In particular, the 1980 and 1977 year-classes contributed about 26% and 32%, respectively, to the 1985 catch.

In order to determine yield options for 1987, landings from the 1986 fishery must be incorporated into the model currently in use.

Recommendations - The 1987 yield options will be presented at a later date when all of the most current biological information has been collated and incorporated into the assessment.

Dogfish

Coastwide (not including Strait of Georgia)

Stock condition - The model of Wood et al. has been updated with catches to 1985. The predicted pulse in abundance set in motion by the 1940's liver fishery is leveling out from the downward trend in abundance. At current harvest levels of less than 2000 t, the marketable biomass of dogfish is predicted to begin increasing over the next two decades. The estimated biomass coastwide at the present time is approximately 300,000 t. If it is assumed that one-half to two-thirds of the stock resides off the coast of Canada, the biomass of fish in the Canadian zone is between 150,000-200,000 t.

Recommendations - Yield options may be chosen from:

Yield option 1: Unlimited yield
Yield option 2: Pulse fishing
Yield option 3: Sustained yield - low risk - 15,000 t
Yield option 4: Sustained yield - high risk - 25,000 t

The risk involved is based on ranges of compensatory mortality and starting stock sizes used to determine the sustainable yields. All options refer to coastwide (including U.S.) removals and no provision has been made for adjusting Canadian catches in the event of increased U.S. landings.

Strait of Georgia - Puget Sound

Stock condition - The model of Wood et al. has been updated to include 1985 catches. The model predicts that the downward trend in abundance has levelled off and that at current harvest levels (approx. 3000 t) abundance should begin to increase sharply over the next 10 to 15 years. Current biomass levels are in the order of 69,000 t.

Length-frequencies of fish from trawl and longline landings show no change in mean length of fish or in the maximum size of fish landed.

Recommendations - Yield options may be chosen from:

Yield option 1: Unlimited yield
Yield option 2: Pulse fishing
Yield option 3: Sustained yield - low risk - 2000 t
Yield option 4: Sustained yield - high risk - 3000 t

The removals in yield option 3 and 4 refer to the Strait of Georgia only.

Walleye pollock

Strait of Georgia

Stock condition - There have been no additional analyses conducted since the previous assessment. The assessment is based on Gulland's equation where MSY - $a(M)(B_0)$.

Recommendations - Yield options for 1987 may be chosen from:

Yield option 1: Conservative level of 2500 t
Yield option 2: High risk level of 5400 t

West coast Vancouver Island

Stock condition - Length-frequency samples suggest that the size composition of the stock in 1985 has remained unchanged from the previous years. This indicates the relative stability of the stock.

Recommendations - The yield option remains unchanged from last year's.

Yield option 1: Unlimited yield
Queen Charlotte Sound
Yield options are not proposed for this region.

Hecate Strait

Stock condition - Size composition of the 1985 landings has remained relatively constant compared with the previous years. Modal sizes remained the same at 50-53 cm. Age-frequency data indicate that 5- and 7-yr-old pollock dominated the catches in 1984.

Recommendations - The yield option proposed for 1987 is the same as for 1986, that is, unlimited yield. The Canadian catch is currently limited by intermittent availability and/or weak market demand.

West Coast of Queen Charlotte Islands

Yield options are not proposed for this region.

Slope Rockfishes

Coastwide quotas - Slope rockfish (S. aleutianus, S. alutus, S. reedi)

For the 1987 fishing year a coastwide yield option for slope rockfishes is presented, based on the same concept of managing a core production area as outlined in 1985. Conservative and sustainable yields for a combined S. alutus/S. reedi coastwide option are 2500 and 3100 t,

respectively. For S. aleutianus, the comparable figures are 100 and 250 t. As in 1985, managers are urged to consider this coastwide option only after examining the cost/benefit ratio of stock-specific vs. coastwide management, as imperfect as the former might be.

Southwest Vancouver Island Pacific ocean perch (Sebastes alutus)

Stock condition - The 3C S. alutus stock is in poor condition. The 1979 surveys by the U.S. and Canada showed an estimated S. alutus biomass of ≈ 9730 t in the 3C area. The 1985 surveys showed a combined biomass of only ≈ 3880 t, of which the Canadian zone contained approximately 1850 t. The decline in S. alutus biomass in the Canadian zone from 1979-1985 was 56% and that for the U.S. zone was over 63%. LPUE declines for the Canadian fishery between 1979 and 1986 are also of this magnitude (49%). In the Canadian zone this decline was associated with a deliberate, short-term over-fishing experiment, while in U.S. waters it was associated with excessive harvest arising from what we believe to be an incorrect estimate of natural mortality. The net result in both cases was harvest well in excess of the sustainable yield. If the decrease in biomass suggested by the two most recent surveys is correct is is also apparent that recruitment to this stock has been minimal in the 1979-1985 interval; mean age continues to be less than 15 y.

Recommendations - It is apparent that the 3C S. alutus stock is in serious need of rehabilitation. U.S. scientists are recommending a 0 t quota for 1987 in the INPFC Vancouver Area (U.S.) in order to initiate the rehabilitation of this stock. A 1985 biomass survey suggests a sustainable yield of approximately 100 t under a F_{opt}=M policy. It is unlikely that such a yield could be controlled in a directed fishery and a non-directed fishery should be considered.

Queen Charlotte Sound/Northwest Vancouver Island yellowmouth rockfish (Sebastes reedi)

Stock condition - No analytic assessments of this stock have been conducted due to the paucity of useful catch or biological data. A single hydroacoustic estimate of biomass (2000 t) was produced in 1978 and is assumed to be conservative. Previous assessments have treated the yield from such a biomass estimate as the minimum sustainable. However, the lowered level of LPUE at harvests above this yield causes some concern, particularly considering the major decrease in directed effort over the 1983-1985 period.

The shift in effort to the northwest coast of Vancouver Island (Area 3D) appears to be largely an artifact of the coastwide management plan and the associated closure of the mouth of Queen Charlotte Sound, where LPUE was much higher for S. reedi. The recommended quotas for Areas 5A/B should apply to this northern Area 3D for an additional period sufficiently long to permit evaluation of their validity.

While biological data for this stock are limited, the gross

estimation of Z was examined by comparing recent biological samples with simulated length frequencies for various Z values generated. These comparisons indicate overall Z values for this stock are presently in the 0.08-0.12 range. In turn this suggests present levels of F (F=M=0.06) for this stock are appropriate.

Recommendations - In consideration of the all-nation catch history and low level of LPUE relative to recent years, it is recommended that yield levels for conservative and sustainable options remain as in 1985, i.e. 200 and 350 t. Future assessments should examine the LPUE and Z indices for stability or positive changes under the yield options chosen, although the limitations of LPUE as an indicator of abundance for rockfishes, particularly concerning mid-water trawling, must be acknowledged.

Queen Charlotte Sound Pacific ocean perch (S. alutus)

Stock condition - The 1977-1985 trawl fisheries on this stock resulted in very high levels of F (0.08-0.20) relative to the projected optimum of F=0.05-0.06. Over 9000 t of S. alutus has been removed from the stock since 1977, at which time biomass was estimated analytically to be about 13,000 t. Clearly, recruitment would have had to be substantial to offset such removals, but age frequency spectra of 1985 samples indicate no strong cohorts recruiting during that period. If recruitment had been on the order of natural mortality (5%/yr) over the 1977-1985 interval, then stock biomass might be estimated at approximately 9000 t in 1986. Unfortunately, little information is available on recruitment at low stock levels for this species. If recruitment had been largely a failure over this interval then a minimum stock estimate would be approximately 4000 t. A biomass survey of the Goose Is. stock in 1984 produced a biomass estimate of ≈ 6800 t.

Using the 1985 age spectrum of the Goose Is. gully stock as a starting point the behaviour of the stock to various fishing mortalities was simulated over 10-, 20-, 30-, 100-, and 200-yr periods. Due to the nature of the population and the manner in which recruitment is modelled (stochastic Ricker function), these projections are less meaningful for periods very close (<10 yr) to the starting point. Nonetheless, it is evident that yield from the present biomass is considerably below that derived from the 1977 biomass. Long-term (200 yr) yield continues to identify F=0.05-0.06 as the F_{opt}, although substantive rehabilitation over a 30-yr horizon occurs only for F=0.0.

Recommendations - In view of the continued decline of the Goose Is./Mitchell's gullies stock of S. alutus the estimated conservative and sustainable yields were reduced to 400 t and 500 t, respectively.

Dixon Entrance slope rockfish (Areas 5E(N))

Stock condition - The 5E(N) rockfish stocks remain at a low level of abundance. The shift in species composition from alutus to reedi/proriger

despite increased effort for the former endorses this lowered abundance. This shift has occurred despite lower LPUE for these alternate species. Since this experiment began the percentage of S. alutus ≥40 cm has dropped from 44.5% to 7.5%, indicating a major change in the population. Age spectra for S. alutus in the area show no sign of incoming strong cohorts and the stock will probably remain depressed until the experiment is completed.

Recommendations - The open-fishing experiment for this area should be continued through 1987, following which another assessment of the stock will be conducted and new yield options identified.

Shelf Rockfish (silvergray, yellowtail, and canary rockfish)

Yield options (t) for shelf rockfish (silvergray, yellowtail, and canary) for 1987 may be chose from:

Area	Rockfish species	Conservative	Sustainable	Non-sustainable
Coast	Silvergray	750	1500	2250
	Yellowtail	750	1500	2250
	Canary	650	1275	1900
	Canary and silvergray	1200	2400	3600
3C	Silvergray	non-directed	100	200
	Canary	n.d.	200	300[a]
	Canary and silvergray	n.d.	250	400[b]
3C+D	Yellowtail	n.d.	250	450
3D	Silvergray	150	350	700
	Yellowtail	n.d.	150	250
	Canary	300	550	800
	Canary and silvergray	400	800	1500
5A+B	Silvergray	400	750	1100
	Yellowtail	500	1500	2500
	Canary	250	500	750
	Canary and silvergray	500	1100	1700
5C+D	Silvergray	300	600	900
	Yellowtail	200	500	750
	Canary	150	300	600
5E(N)	Silvergray	----------	100[b]	----------
	Yellowtail	----------	200[b]	----------
	Canary	----------	200[b]	----------
5E(S)	Silvergray	----------	350[b]	----------
	Yellowtail	----------	200[b]	----------
	Canary	----------	200[b]	----------

[a]Joint international quotas recommended if catches exceed suggested non-sustainable levels.
[b]Little knowledge of resource status.

Pacific Stock Assessment Review Committee

Steering Committee Review of PSARC Advisory Document 86-2

Advice on the Management of Pacific Groundfish Stocks in 1987

A. Tyler presented the Groundfish Advisory Document.

It is suggested that the groundfish report contain a table ranking stocks according to importance (i.e. total catch).

The steering committee also suggested future documents should include:

i) a paragraph clearly defining management policy.

ii) a paragraph identifying weak links and flag fisheries concerns.

iii) address long-term biological objectives and harvest potentials.

iv) attach list of working papers.

The report was APPROVED by the committee.

Approved for release by Fisheries Resource Management Executive Committee

Pacific Stock Assessment
Review Committee

PSARC Advisory Document 86-3

Advice on the Management of Pacific Invertebrate Stocks for 1987

This advisory document is a summary of advice and recommendations from meetings of the Shellfish Stock Assessment Subcommittee to the Shellfish Working Group. Twenty-five papers were presented at a meeting held September 2nd and 3rd, 1986.

Presentations were made by biologists and scientists from the Fisheries Research Branch and biologists from the north and south coast divisions of the Fisheries Branch.

Recommendations from this committee were reviewed by the Shellfish Working Group and formed the basis of fishing plans presented to industry at public meetings. The fishing plans are published in an annual commercial fishing guide for shellfish and minor finfish species.

The development of management advice was organized by gear type (trap and net, diving, and intertidal) and then by species. Effort, landings and value of invertebrate fisheries have increased significantly in the past 4 years. Landings for 1984 and 1985 are shown in Table 1. The total landed value for invertebrate fisheries in 1985 exceeded $18 million.

Some fisheries have limited entry licenses [abalone (26), geoduck and horse clam (55), and shrimp trawl (249)] but the majority are open to over 6,000 eligible vessels.

Quotas are set for some species (abalone, geoduck, sea urchins, sea cucumbers, euphausiids), some are managed by active enforcement of size limits (intertidal clams, crabs, scallops) and some species require in-season management programs (prawns). Some species are considered to be underutilized and fisheries are carried out with few, if any, restrictions on an exploratory basis (inshore squid, octopus, goose barnacles, and mussels). Exploratory experimental fishing for offshore squid has been closely monitored and regulated.

1. Euphausiids (Plankton)

The stock is considered to be underexploited. Landings in 1985 were 130 t, landed by only two vessels. This night-time, small boat, trawl fishery has remained inshore, although large offshore stocks are available. There is expected to be increased effort in this fishery to supply food for the salmon aquaculture industry.

Recommendations

Management

- The quota of 453 t should remain the same pending research and development of the fishery.

- Due to current low levels of effort there should be no seasonal harvest restrictions.

Research

- A cooperative research program should be developed with harvesters to estimate biomass and production and day/night changes in concentrations. Year round data is needed.
- Monitoring of the fishery, through catch sampling, to determine by-catch of fish/shellfish larvae should be reinstated if the fishery continues beyond the period of December through March.

2. Inshore Squid (Loligo)

The Loligo squid resource is considered to be underexploited, partly due to the erratic occurrence of spawning aggregations. Landings were 126 t in 1985 from 26 vessels using seine nets. Squid are sold for bait in the blackcod, halibut and crab fisheries.

Recommendations

Management and Research

Monitoring of effort and landings by logbooks should be continued.

3. Offshore Squid

Further exploratory fishing (gill-nets) for flying squid, Ommastrephes bartrami, should be encouraged to define resource and fishing characteristics.

Recommendations

Management

Canadian involvement in the fishery should be encouraged.

Research

- Determine the biology and distribution of the stock, particularly if this fishery develops further.
- Better evaluation of water temperature on CPUE and by catch characteristics.
- Evaluate how by-catch can be minimized.

4. Octopus

Octopus stocks are considered to be underexploited. The fishery is small with directed effort by traps and diving, and incidental landings from trawl fisheries. Landings reported in 1985 were 34 t. Most octopus are used as bait in the halibut fishery.

Recommendations

Management and Research

No significant management or biological research effort should be devoted to this fishery at this time. Catch and effort should be monitored through the logbook program in place.

5. B.C. Shrimp Trawl Fishery

The shrimp trawl fishery targets primarily on three species of shrimp, Pandalus jordani (smooth pink), P. boreali (pink) and Pandalopsis dispar (sidestrijae). The three main areas of shrimp trawling are the west coast of Vancouver Island, the Strait of Georgia, and Chatham Sound. Landings are down in all areas in comparison to the long term average.

Recommendations

A. Offshore - West Coast of Vancouver Island

Management

- Catch restriction may be required if there is a rapid expansion of the fishery.
- Offshore shrimp landings are being reported incorrectly on sales slips and should be reported for areas of catch, not point of landing.
- A review of the shrimp licence and shrimp trawl permits in Barkley Sound should be undertaken.

Research

- Stock surveys of west coast areas should be conducted biannually in odd-numbered years, beginning in 1987.
- An in-depth assessment of existing biological data should be conducted to investigate:
  (a) procedures of estimating year-class abundance.
  (b) abiotic and biotic mechanisms that might be affecting recruitment.
  (c) management options, and their biological implications.

B. Inshore

Management

- A mandatory logbook system for "S" licenses should be established in conjunction with biological monitoring in 1987.
- The shrimp trawl licence policy requires review.
- The problem of incidental and targeted catches of prawns in the shrimp trawl fishery should be investigated. An acceptable level of by-catch of prawns should be determined.
- When areas are closed to prawn trapping, non-retention of prawns must be enforced to keep trawlers off prawn areas.

- The use of otter trawls in areas, such as Area 17, that serve as a nursery area for a variety of fish, should be restricted. Only beam trawls should be used.
- Enforcement/surveillance of the inshore fishery via patrol vessel log reports should be increased.

Research

- Independent checks on the accuracy of logbook and sales slip data using fishing activity logs for DFO staff should be conducted in 1987.

6. Clam size limits

A historical review of size limits in the intertidal fisheries was presented. Alternate management strategies, seasonal closures, beach closures and quotas were discussed.

Recommendations:

Management

- Management by minimum size limit is the most practical option available to manage intertidal clam fisheries at this time. There needs to be continued enforcement of size limits to ensure adequate breeding stock.

Research

- The rationale for existing size limits needs to be documented based on current biological data.
- Yield per recruit predictions should be made to determine optimum size limits for maximum yield.
- Different exploitation options should be evaluated, for example, one year spawning prior to entering the fishery versus two or more years of spawning.

7.-9. Butter clams, Manila clams, Littleneck clams

Landings of manila and littleneck clams continue to increase. As noted in (6) management by minimum size limit should be the primary strategy. There are seasonal closures on the west coast of Vancouver Island due to high risk periods of PSP and a lack of resources to undertake monitoring and enforcement of size limits.

10. Razor clams

Recommendations:

Management

- If the razor clam fishery expands at Masset, Queen Charlotte Islands, then the effectiveness of the size limit and the possibility of an annual quota should be examined.

Research

- No research planned for 1987.

11. Sooke coonstripe shrimp trap fishery

A small shrimp trap fishery in Sooke Basin exists. A catch monitoring and logbook program has been in effect for several years.

Management

- Initial advice suggests a TAC of 2 t. If a fishery does occur the harvest should be restricted to a period of only 3 weeks when the market gives maximum value (i.e. during the regional prawn closure). Options should be presented to fishermen at an industry meeting.

12. Mussels

There is only a minor fishery for wild mussels, with less than 5 t landed annually. There may be potential for aquaculture of mussels.

Recommendations:

Management

- Policies are required to facilitate the achievement of an area's maximum mussel culture potential in relation to harvest and/or culture of other species.
- Restrictions on imports of live mussels should be discussed to prevent possible introduction of diseases.

Research

- An integrated research/extension service should be developed to ensure that a maximum harvest can be routinely produced.

13. Gooseneck barnacles

A small fishery (2 t) was initiated in 1985/86, with shipment of live goose-barnacles to Spain. A study is in progress to assess the biological impacts of harvest.

14. King, tanner, red rock and galathid crabs

There are not currently any significant landings of these species.

Recommendations:

Management

- tanner and galathid crabs should be specified in the regulations and licence requirements so that fishery monitoring can be more easily achieved.
- A size limit for golden king crab (181 mm) should be discussed, with no size size limit in effect for thizocephalan parasitized crabs.

15. Dungeness crab

The Dungeness crab fishery remains generally stable, but there are expectations of lower landings from the west coast of Vancouver Island in the near future arising from a recent lack of larval settlement. Mechanisms influencing year class strength remain poorly known. In 1985, this was one of the major invertebrate species regionally in terms of landed value ($4.7 million).

Recommendations:

Management

- Key problems are the landing of soft shell crabs and ghost fishing by lost gear. Biological advice has been provided and economic evaluations may be required.

Research

- Establish explanations for fluctuations in magnitude of landings in the various fisheries.

16. Options for escape opening regulations for traps in the B.C. prawn fishery

As an alternative to a minimum size limit for prawns, various trap modifications were evaluated to allow escapement of sublegal size prawns without significant loss of legal size prawns.

Recommendations:

Management

- Evaluate Washington State and Alaska mesh restriction regulations.
- An implementation schedule for mesh size regulations should be discussed with industry.

Research

- Further studies are to be carried out in Saanich Inlet during November 1986, to establish specific optimum mesh size regulations.

17. Prawn Trap Fishery

Effort (number of vessels and traps) and landings have increased greatly in the past ten years. In 1985, 241 vessels reported a total landings of 511 t for a landed value of $2.5 million.

Recommendations:

Research/Management

- Various alternate management scenarios should be developed and evaluated using biological data collected from experimental prawn fishing areas.
- The usefulness of the logbook data base, in conjunction with the biological sample data base, should be evaluated for stock assessment purposes. Biological sampling procedures should be standardized for all fisheries staff gathering biological information on prawn stocks.
- For independent checks on logbook and sales slip data quality, we need to develop:
  (a) a standard format for data to be submitted from the biological monitoring program;
  (b) standardized patrol vessel logs.

18. Scallops

There are only occasional minor trawl landings of weathervane scallops. A small diving fishery, 53 t, for pink and spiny scallops continued in 1985.

Recommendations:

Management

- The restriction on drag size should be reviewed, particularly for the north coast area.

19. Size limits for pink and spiny scallops

Fishermen and processors have requested that the minimum size limit for pink and spiny scallops be reduced from 60 mm to 55 mm shell height.

Recommendations:

Research

- Further biological data is required on pink scallops before final recommendations can be made for size limits.

20. Abalone

The abalone fishery has had a quota set at 48 t for the past 2 seasons, divided equally among 26 licence holders. The stock is depleted and recruitment low compared to earlier years in the fishery.

Recommendations:

Management

- An exploratory fishery for one or two vessels in Area 27 should be considered at the next working group meeting.
- The rationale for open and closed areas for the whole coast need to be documented and evaluated.
- A survey of fishery officers should be conducted to estimate levels of poaching in specific areas.
- The current bag limits for the sports fishery should be discussed in an attempt to establish consistency.
- The quota should remain the same for 1987 as there are indications of stock stabilization in central coast areas.

Research

- A study should be conducted to examine benefits from an increased size limit.
- The Queen Charlotte Islands should be resurveyed in 1987 to document any possible abalone stock improvement.
- Stock estimation by stock reduction analysis should be examined further.

21. Geoduck clams

There are 55 licenses issued to harvest geoducks by divers. Annual landings have increased with expansion of the fishery into the north coast. In 1985, 5370 t were taken at a landed value of $4.8 million, making it the major invertebrate fishery in forms of volume and landed value.

Recommendations:

Management

- Quota levels should remain the same for 1987 unless sufficient additional sufficient fishing areas are identified to warrant an increase.

- A cooperative plan should be developed with industry to maintain a year round supply of live geoducks for 1987. Harvesters need to discuss herring spawn closures directly with the herring working group committee.

Research

- The extent of deepwater stocks should be investigated.
- Survey techniques and stock assessment require more resources than are presently available.
- At least three study areas should be established to investigate stock abundance and to monitor recruitment after harvest.
- An assessment of recruitment on harvested grounds (areas to be identified by industry) should be carried out.
- The development of hatchery techniques should be monitored and trial seeding of juvenile geoducks should be considered.

22. Horse clams

There has not been a recent market for horse clams and little fishing activity has taken place. Accordingly, no changes are recommended. Some areas (Area 24) are closed to protect herring spawn vegetation. Harvesters need to discuss area closures with the herring working group committee.

23. Red sea urchins

This fishery is growing rapidly and is currently the second most valuable dive fishery. Landings in 1985 were 1815 t with a landed value of $763 thousand. The season is limited to the period of peak market demand, October 15 to February 15.

Recommendations:

Management

- Quota levels in the 1986 management plan should continue for 1987.
- Additional "arbitrary" quotas may have to be implemented in-season depending on fishing locations and intensity of harvest. The 100 mm minimum size limit should remain in effect.
- Logbook data should be analyzed in areas of heavy exploitation. Stocks in Areas 14 and 19 are reported to be depleted.

24. Sea cucumbers

The sea cucumber dive fishery has grown slowly due to limited markets. Landings in 1985 by 21 vessels were 346 t.

Recommendations:

Management

- All south coast areas should be opened to cucumber fishing. Logbooks should be continued to monitor landings and CPUE.
- A quota of 500 t for the north coast should be retained in 1987 to limit the fishery until more is known about stock abundance and recruitment.
- Areas 28 and 29 should be opened with monitoring of landings and CPUE through logbook returns. Research areas in Indian Arm should remain closed to commercial fishing.

Research

- The logbook data base should be analyzed to determine appropriate levels of harvest.

SHELLFISH TABLE

Table 1 - Summary of 1982 to 1985 catch statistics for Z licence species

Species	1984 Landings (t)					1985 Landings (t)				
	North Coast	South Coast	Fraser Area	1984 Total	Value 10^3	North Coast	South Coast	Fraser Area	1985 Total	Value 10^3
SHELLFISH										
Prawn	112	353	39	504[1]	2,304	99	368	47.1	514	2,461
Red sea urchin	0	1,828	5.7	1,834[1]	740		1768	47.3	1815	762
Sea cucumber	0	113	0	113[1]	26		344	1.5	346	91
Squid	41.7	13.6	15.0	70.3[1]	86	3.1	123	0.1	126	139
Octopus	14.3	16.0	*	30.4[1]	64	9	24.3	0.1	34	68
Euphausiids	0	93.6	0.3	93.9[1]	38		118.8	3.3	122	n/a
Scallops (weathervane and pink and spiny)	3.6	23.0	0	26.6[1]	74	0.3	52.6	0.2	53	137
Mussels	--	--	--	--	--				<5	n/a

SHELLFISH TABLE

Table 1 (Continued) - Summary of 1982 to 1985 catch statistics for shellfish species not included in the Z licence

Species/Licence required	1984 Landings (t)					1985 Landings (t)				
	North Coast	South Coast	Fraser Area	1984 Total	Value 10^3	North Coast	South Coast	Fraser Area	1985 Total	Value 10^3
Clams/PCFL[1]										
Razor	95	5.9	0	101	123	90.1			90	95
Butter	*	131	0	131	54		252.2		252	74
Littleneck	0.6	294	0	295	311		192.2		192	202
Manila	*	1,677	0	1,677	1,809		1913.5		1914	2,220
Mixed	9.0	400	0.1	409	454		477.9		478	553
Total clams (from above)	(105)	(2,509)	(0.1)	(2,615)	(2,758)	(90.1	(2835.8)		(2926)	(3,144)
Geoduck clams/G[2]	575	2,908	0	3,482	2,937	1436.3	3933.8		5370	4786
Horse clams/G[2]	0	7	0	7	5		6.3		6.3	6
Abalone/E[2]	46	12	0	58	530	32.0	10.1		42	442
Shrimp trawl/S[2]	32	177	200	409	1,022	34.2	490	153.5	678	1,180
Crab/C[3]	296	518	341	1,155	4,558	274.2	538.3	352.6	1165	4,719

* less than 100 kg.

[1] Personal Commercial Fishing Licence when digging by hand. Mechanical diggers or other apparatus require a Z licence.

[2] These are limited entry licences.

[3] C licence or other that carries C privileges - A, B, G, K, L, S and T.

n/a - not available.

Pacific Stock Assessment
Review Committee

Steering Committee Review of
PSARC Advisory Document 86-3

Advice on the Management of Pacific Invertebrate Stocks for 1987

R. Harbo presented the Invertebrate Advisory Document.

During discussions on shellfish the steering committee identified the need for the Shellfish Subcommittee to define alternative options to exploit shellfish.

The steering committee also suggested future documents should include:

i) a paragraph clearly defining management policy.

ii) a paragraph identifying weak links and flag fisheries concerns.

iii) address long-term biological objectives and harvest potentials.

iv) attach list of working papers.

The report was APPROVED by the committee.

Approved for release by Fisheries Resource Management Executive Committee.

Pacific Stock Assessment
Review Committee

PSARC Advisory Document 86-4

Advice on Pacific Coho

This advisory document is the result of work done by the Coho Technical Committee during the winter and spring of 1986. This work had two main purposes: (1) to respond to a regional priority for salmon stock assessment as requested through PSARC, and (2) to satisfy Pacific Salmon treaty requirements for a Canadian coho status report. The Coho Technical Committee is made up of technical experts from research, management and SEP. A subset of this group forms the Canadian section of the Joint Coho Technical Committee established by the Pacific Salmon Treaty with the U.S.

The management of coho salmon (Oncorhynchus kisutch) in British Columbia has not been as intensive as for other salmon species and is generally aimed at providing directed coho fishing opportunities to the sport and commercial troll fleets and the Indian food fishery. Coho are also harvested as incidental catch in most net fisheries.

Harvest management plans have generally been established in the absence of spawning escapement goals. Escapement information is considered to be unreliable. In addition, the highly mixed stock nature of most coho directed fisheries has made it virtually impossible to collect stock specific catch information on wild stocks without expensive coded-wire tagging (CWT) programs.

Maximum sustained yield (MSY) is the largest average biomass of a stock that can be harvested on a regular basis. MSY is the primary objective in the management of a fish resource but because coho management is based on pieces of fish, rather than biomass, MSY is referred to as MSH or maximum sustained harvest. Since coho are caught entirely in their final year of life these two objectives are not entirely different, although there is considerable growth during this period. MSH is derived from a relationship between spawners and subsequent recruitment.

There are currently no coho stocks in B.C. for which MSH is known. At present the best that can be done is to estimate MSH and manage to this interim goal until more stock information is available.

A Brief History of B.C. Coho Fisheries

Coho salmon in British Columbia are harvested in significant numbers by the commercial, sport and Indian food fisheries (IFF). The total commercial catch of coho salmon, which averaged 3.3 million during the period 1981 to 1985, has shown no distinct trend since 1951 when the current catch statistics system was introduced. The IFF catch has increased in recent years from an average of 49 thousand (1975 to 1979) to 102 thousand (1980 to 1984). The short time series of the sport catch data makes it difficult to determine

any trend but the most recent two years have been the highest since 1980 when the current catch monitoring program began.

Commercial Troll Fisheries

Commercial trollers have been the major harvester of coho in B. C. since the 1920s. The troll fishery for coho has been managed by setting a season each year. Major changes in recent years have included; 1) reduction of the coho season from June 15-October 30 to July 1-September 30 in 1981; 2) area licensing beginning in 1980 (Georgia Strait or outside); and 3) obligations under the new Pacific Salmon Treaty described below. Most regulations have been aimed at harvesting the resource at its maximum biomass recognizing the rapid growth which takes place in the final few months of ocean life. Other regulations such as the six gurdie restriction, the barbless hook requirement and nursery area closures have conservation benefits.

The Pacific Salmon Treaty, which was ratified prior to the 1985 fishing season imposed a catch ceiling of 1.75 million coho on the WCVI troll fishery for the 1985 and 1986 seasons.

The northern troll catch has been trendless over this period with current catches (1981 to 1985) averaging 508,000 pieces. The north central coast catch has declined from over 200,000 in the early seventies to an average of 78,000 for 1981 to 1985. The 1985 catch in the south-central troll fishery was the lowest on record but there is no clear trend since the mid-sixties. Interpretation of catch data in the Georgia Strait troll fishery is confounded by changes in regulations noted above. Recent catch levels are below historic levels but could reflect effort reduction rather than reduced availability. The southwest Vancouver Island troll fishery shows a marked increasing trend since the late fifties. This could be due either to increased abundance coincident with increasing hatchery output or increased effort; a combination of both is likely. The northwest Vancouver Island troll fishery has increased slightly over the period of record, perhaps due again to increasing hatchery contributions.

Sport Fisheries

Sport fishing in British Columbia occurs mainly in Georgia Strait. The Georgia Strait sport fishery extends from Sheringham Point, near Sooke, to Stuart Island, north of Campbell River. The 1985 catch in this fishery was estimated to be 728,000, the highest since 1978. In addition to this tidal fishery there is also a non-tidal sport fishery in streams draining into Georgia Strait. Other areas in B.C. with smaller sport fisheries include Barkley Sound, Rivers Inlet, the Skeena, Nass and Fraser rivers and many of the inlets and streams on the Queen Charlotte Islands.

Tidal sport fishing is open to anglers year round and in Georgia Strait involves approximately 600,000 boat trips annually. Peak fishing activity occurs in the summer months from June to September when 80% of the

coho are caught. The minimum size limit for coho is 30 cm and daily bag limits in tidal waters are for 4 salmon per day of which only 2 can be chinook. There is a seasonal bag limit of 20 fish per angler for chinook but no limit for coho.

Recent British Columbia troll and sports catches (no. of pieces) are shown below:

Year	North 1-5	Centr/N 6-8	Centr/S 9-11,30	Geor St 12-20,29	SWVI 21-24	NWVI 25-27	US Wtrs South	US Wtrs North	Total Troll	Geor St Sport
1977	202028	86330	141850	197604	1245107	323302	52022	1	2248244	682000
1978	516033	140764	178145	374250	955494	405458	0	0	2570144	1103000
1979	448329	114555	172979	256974	1365221	547809	0	0	2905867	414000
1980	519129	85494	205655	178888	1297543	408280	0	0	2694989	642000
1981	375614	69829	185391	95512	1026915	358408	0	0	2111669	406000
1982	393568	50046	128245	148834	1324420	464096	0	0	2509209	454000
1983	732885	108409	324539	121209	1690720	478424	0	0	3456186	404000
1984	531096	117976	210098	116907	1668254	503781	0	0	3148112	443000
1985	527712	43719	83142	199878	1012075	376961	0	0	2243487	728000

Notes: (1) Commercial catch data for 1977 to 1985 are from published catch statistics (Dep. Fish and Oceans).
(2) 1977-78 sport catch estimates are from Argue et al. The sport catch for 1979 is the average of the brood year data (1973, 1976, 1982). Sport catch estimates are for Georgia Strait only (Areas 13-20, 28 and 29) (Georgia Strait creel survey 1980-85). Data for other areas have not been compiled and verified at this time.

Net Fisheries

Since the mid-seventies coho directed net fisheries have been uncommon and have occurred only in terminal areas where surpluses have been identified.

Almost the entire catch is taken incidentally during fisheries targeting on sockeye, pink or chum. In the south, the Johnstone Strait and Juan de Fuca fisheries are the major harvesters. The catch in Juan de Fuca Strait has been greatly reduced in recent years since coho fisheries after decontrol by the I.P.S.F.C. have been eliminated. In the north, most of the net catch is taken during the pink and sockeye fisheries in the approaches to the Skeena and Nass rivers and pink fisheries in the central coast.

The recent net catch (no. of pieces) of coho by statistical area groupings is shown below. The total B.C. net catch has declined since the mid-sixties from 1,472,000 (1964 to 1968) to an average catch of 636,000 in recent years (1981 to 1985).

Year	Q.C.I. (1, 2E,2W)	Nass/ Sk (3-5)	Centr/ N (6-8)	Centr/ S (9-10)	Johnst St (11-13)	Georg St (14-18)	Fraser (29)	WCVI (21- 27)	Ju de F (20)	Total net
1977	18671	132779	48674	54116	228658	11378	42230	50333	505648	1092487
1978	19570	175227	150695	26829	191024	7900	51021	12374	103230	737870
1979	41736	99344	131636	10698	116685	1147	7710	8339	255358	672653
1980	50124	75702	141996	3896	162995	6677	33369	14905	157071	646735
1981	28160	57853	108490	4480	201216	12353	5181	7392	278186	703311
1982	14775	172464	102838	7913	194317	9028	19312	13346	127601	661594
1983	9995	206717	146863	6550	243281	16293	11322	9210	16943	667174
1984	19439	143689	52409	7961	119116	13585	9192	10561	74859	450811
1985	49046	127304	83888	13010	147230	31774	18179	7509	224757	702697

Note: Data for 1977 to 1985 are from published catch statistics (Dep. Fish. and Oceans). Hatchery rack sales which were placed in the gillnet catch for Areas 13, 23 and 28 in the years 1978 and 1979 have been removed.

Indian Food Fishery (IFF)

Coho salmon constitute 10 to 15 percent of the coast-wide Indian food fishery salmon catch. Coho catches have averaged approximately 100,000 during the period 1980 to 1984 and have generally increased over the period of record. An estimated 64 percent of the coast-wide Indian food fishery coho catch is taken in the Fraser River and Skeena/Nass regions. The food fishery in the Fraser River is the largest on the coast, taking an average (1980 to 1984) of 30,900 coho, 31% of the coast-wide total. The food fishery in the Skeena and Nass rivers harvested an average of 21,200 coho during the same period, 21% of the coastwide total. Recent British Columbia Indian food fish coho catches and total all gear catches (no. of pieces) are shown below:

Year	Q.C.I. (1,2E,2W)	Nass/Sk (3-5)	Central (6-10)	Johnst St (11-12)	Geor St (13-18)	Fraser (28-29)	WCVI (19-27)	Total Indian catch	Total catch all gear
1977	200	4536	3469	478	4666	22662	80	36091	4058822
1978	50	9976	2669	300	3416	32220	92	48723	4459737
1979	0	5054	1525	1200	38679	25532	1153	73143	4065663
1980	125	7609	4449	0	42094	44492	2863	101632	4085356
1981	350	7457	3522	6	64100	20558	2330	98323	3319303
1982	175	28521	3405	219	20287	64027	2952	119586	3744389
1983	130	31189	3284	298	25062	13804	630	74397	4601757
1984	20	31114	3350	552	6775	71303	2465	115579	4157502

Note: Indian food fish figures are from James (unpublished, 1984). Some catch data originally reported in Cwt. units was converted to pieces using piece per Cwt. conversion from commercial gillnet fisheries in appropriate area and year. 1984 data is preliminary. 1985 data is unavailable at this time.

Qualitative Stock Assessment by Major Stock Aggregates

Existing data on most B.C. coho stocks does not permit quantitative assessments of status at this time. The following qualitative assessments are organized by 8 major aggregate groups:

Queen Charlotte Islands - Areas 1, 2E
Skeena/Nass - Areas 3 to 5
Central Coast - Areas 6 to 10
Johnstone Strait - Areas 11 and 12
Georgia Strait - Areas 13 to 19
Fraser Region - Areas 28 and 29
West Coast Vancouver Island - Areas 20 to 27
Enhanced Production

Queen Charlotte Islands

Area 1 - Current escapement is estimated to be one-half of the 1960's level. There is currently no information on ocean harvest distribution and exploitation rates for these stocks.

Area 2E - Exploitation rates are in the 30 to 40 percent range. Although escapement estimates are below historic levels, the low harvest rates estimated for the Cumshewa Inlet hatchery stock should be sustainable by most wild coho stocks.

Area 2W - No assessment.

Skeena/Nass

Area 3 - Escapement has been stable for the last fifteen years and appears to be increasing in some areas. In the Meziadin, the 1985 fishway count (4,300) was the highest on record.

Area 4 - Upper Skeena and Bulkley River coho stocks are particularly depressed and require immediate conservation action. Total terminal run size to the Skeena River appears to be stable at a level much lower than the 1950s and 1960s. Estimates of escapement, the Babine fence count and test fishery indices all point to a decline, while terminal gillnet catch per unit effort (CPUE) does not indicate a clear trend. In response to the decline in terminal run, however, net fisheries have been restricted in recent years to sockeye and pink directed fisheries only. Despite these restrictions, a considerable overlap in timing still produces a significant coho harvest in these fisheries.

Area 5 - Current escapements are very low compared with the 1960's mean.

Central Coast

Area 6 - The escapement levels in Area 6 are currently less than half of previous highs with escapements to southern stocks more severely depressed than the northern ones. Stock status is unclear but declining troll catches in this area could be signalling less than optimum production.

Area 7 - Current escapements are estimated at less than 2,000. This is less than 10 percent of historical levels. There is currently no information on ocean harvest patterns. Tagged smolt releases from the McGlaughlin Bay community hatchery beginning in 1986 should provide some ocean distribution information in the near future.

Estimated escapements have shown a steady decline to less than one half the 1950s level.

Area 9 - The current estimated escapement is slightly higher than historic levels.

Area 10 - Current total escapements for the area is less than 2,000 spawners which is only slightly below historic levels.

Johnstone Strait

Area 11 - CPUE by anglers in the Seymour River has been very high in recent years, indicating that abundance is probably higher than for southern Georgia Strait stocks. Gillnet chum fisheries on local stocks were eliminated in the early eighties in response to declining abundance (based on fishery officer observations) and this has undoubtedly increased coho as well as chum escapements. There are no CWT data for these stocks and there are no plans to begin this type of assessment work in the near future.

Area 12 - CWT returns from 1976 brood wild Keogh River smolts indicate that the majority of the catch is taken in troll fisheries off the west coast of Vancouver Island and in the central coast area. Significant catches are also taken in the Johnstone Strait net fishery. At the time of tagging very few fish were caught in sport fisheries but this component of the catch has probably increased for reasons mentioned above. Coho pre-smolts from the Devereaux River in Knight Inlet were tagged in 1986 and information on catch distribution and exploitation rates will be available in the near future.

Stocks on the Vancouver Island side are believed to be in decline and enhancement activities have been redirected from other species onto coho in some streams. Coho in this area are very large in size and the sport fishery on these stocks has been increasing in recent years. Some streams such as the Kluxewe River have been particularly impacted by logging activity and this along with fishery impacts both targeted (sport and troll) and incidental (during net fisheries on other species) have probably contributed to the declining trend.

Area 13 north - No assessment.

Georgia Strait

Georgia Strait coho production comes from a variety of sources that can be conveniently grouped into four categories: mid-Vancouver Island, south Vancouver Island, mainland inlets, and hatcheries.

Mid-Vancouver Island

Spawning escapements to these streams are believed to be depressed. Remedial enhancement measures are being taken in most of these streams in an attempt to rebuild stocks to previous levels. Spawner and smolt enumeration fences are currently in place on the Trent River and Black and French creeks; data from these operations should provide evidence on the status of these stocks. Black Creek is scheduled to continue as part of a key stream monitoring program which will permit annual evaluation of stock status and eventually a better understanding of the stock-recruit parameters which are applicable to Georgia Strait wild stock.

Fishery exploitation rate on the Big Qualicum River hatchery stock has been over 70 percent in most recent years; this rate is considered to be excessive for wild stocks and should be reduced if MSH is to be achieved.

Coded-wire tagging of 1976 and 1977 brood Black Creek coho smolts indicated that over 40 percent of the B.C. catch of this stock was taken in each of the sport and troll fisheries. Troll catch was distributed between fisheries in Georgia Strait, the west coast of Vancouver Island and the central coast. The net fishery in Johnstone Strait had a smaller but still significant impact. Recent CWT data from the nearby Puntledge River hatchery indicates an increasing net fishery catch and variable distribution between the sport and troll fisheries. This variability could be due to interannual differences in the rate of out migration of these stocks from Georgia Strait suggested by changes in the catch distribution of Georgia Strait hatchery stocks.

South Vancouver Island

The Cowichan River system, the largest watershed in this area, supports the largest wild coho spawning escapement on Vancouver Island. Escapements of over 20,000 have been reported in recent years with historic levels being in excess of 50,000.

CWT's from the 1973 brood release of wild Cowichan River coho were recovered primarily in Washington (49%) and the west coast of Vancouver Island (30%). This contrasts with more northerly Strait of Georgia stocks which are caught primarily in inside waters. In light of changes in exploitation patterns in recent years and the importance of this stock there is a need to update this information.

Georgia Strait mainland inlets

CWT recovery data for 1979 and 1982 brood Sliammon River enhanced stock suggests that these fish are caught primarily in Georgia Strait sport and troll fisheries and in small numbers in the Johnstone Strait net fishery. Contribution to outside fisheries seems to be minor.

Fraser River Region

Fraser River - Return to the river and escapement data for the Fraser River system are felt to be reasonable indicators of stock trends due to a high correlation between these indicators and an in-river test fishery index. Coho escapements have declined by an average rate of 1% per year since 1970, the period during which test fishery information is available. Current escapement levels are less than one third of the interim goal of 175,000 spawners. (This figure is the current basis for management as indicated in the Canadian report to the Pacific Salmon Commission on the 1986 fishery and expectations for 1987.) A reduction in exploitation of this stock is urgently required to reverse the downward trend in escapement.

Squamish River - Since 1970 wild stock escapements have declined at an average rate of six percent per year. More spawners are urgently required.

Seymour River - Recent increases in escapement reflect in part the influence of a small hatchery, with a production potential of 9,750 adults, which was established in the watershed in 1977.

Boundary Bay - The Serpentine and Nicomekl rivers run through urban areas and have been impacted by degradation to rearing and spawning habitat. The Little Campbell flows primarily through agricultural land and appears to be in better condition.

West Coast of Vancouver Island

Robertson Creek hatchery CWT recovery data indicate that almost all of the catch of this stock is taken by the troll fishery along the west coast of Vancouver Island. A smaller component is also taken in the central coast troll fishery. Exploitation rates have averaged about 66% over the period from 1980 to 1985. While there is some indication (declining escapement estimates in some streams) that stocks are declining, this level of exploitation should be sustainable by most wild coho populations. Declining survival rates of Robertson Creek hatchery releases in recent years has created some concern and apparent parallel declines in Carnation Creek survival could indicate an ocean mortality agent rather than a hatchery-related one.

Enhanced Production

Smolt Releases

Smolt releases from major facilities and small community hatcheries have increased from around 0.5 million in the early 1970s to 13.5 million in 1985 (1983 brood year). Approximately 82 percent of the 1983 brood production was from Georgia Strait and Fraser River hatcheries; one half of this production is due to increases implemented for one year for EXPO 86 visitors. These hatcheries contribute primarily to the Georgia Strait sport and troll fisheries and secondarily to the west coast of Vancouver Island troll fishery. Most of the remaining production (13%) comes from the Robertson Creek Hatchery on the west coast of Vancouver Island. These fish contribute almost exclusively to the west coast of Vancouver Island troll fishery. The 1983 brood release of 0.7 million smolts represents the first year of production from hatcheries in the north and central coast of B.C.

The catch of Canadian hatchery fish by Canadian fisheries (commercial and sport) averaged 290,000 over the period 1978-85. The catch has increased in the last three years (350,000 average) after a relatively stable period. Prior to 1985, Canadian hatchery coho made up from 5.5 to 7.6% of the total B.C. catch; the 1985 hatchery component was 12.7%.

Coho hatchery production has been about two-thirds of projected levels (10% actual smolt-to-adult survival versus 15% expected) during the period 1981-85. During the 1970s, overall production rates were higher but this reflected exceptionally high survival of Big Qualicum coho. Big Qualicum production now appears to have stabilized at a rate similar to that of other hatcheries.

The future trend in hatchery smolt releases is expected to be relatively stable since some EXPO production increase will be eliminated while near-new facilities will be building towards their capacities.

Pre-smolt Releases

Pre-smolt coho releases from major facilities and community hatcheries have shown a highly variable but increasing trend since 1971. The 1984 brood release of 9.2 million was the largest on record. Fraser River and Georgia Strait releases accounted for 72% of the total while the west coast of Vancouver Island contributed about 20%.

Pre-smolts are released in either a fed or unfed condition in accessible or inaccessible portions of the hatchery watershed or adjacent watersheds.

Contributions to catch have been measured for some releases but generally the level of assessment for these releases is poor because spawners do not return to the hatchery facility. Survival rates, when measured, have been highly variable ranging from less than 0.5% to as high as 5.0%. Thus, while pre-smolt numbers are high, contributions to fisheries and escapements are much less than for smolt releases.

Recommendations

1) Existing data on most British Columbia coho stocks, while showing declines of many stocks, does not permit conclusive assessment of their status at this time. There is, however, very strong biological evidence that conservation actions are required for the following stocks:

   (a) It is recommended that for Fraser River stocks exploitation rates be reduced to permit their rebuilding to the interim escapement goal of 175,000 wild spawners. Depending upon the rate of rebuilding desired this will mean varying degrees of control on the following aggregate of fisheries in addition to those already in place for net fisheries: (i) Georgia Strait sport; (ii) Georgia Strait troll; (iii) west coast Vancouver Island troll; and (iv) the in-river Indian food fishery.

   (b) Concurrent with the Fraser River problem, there is a growing concern that Georgia Strait wild coho stocks are being over-exploited. Exploitation rates on Big Qualicum hatchery coho are in excess of 70% for all but one year from 1979 to 1985. Complementary to 1) (a) above it is recommended that exploitation rates on Georgia Strait coho stocks be stabilized to an average level of 70% as indicated by the Big Qualicum hatchery stock. The same fisheries as in (a) above are involved with the exception of the Indian food fishery.

   (c) The third stock group for which a well documented conservation concern exists is the Skeena River. Up-river stocks are in especially poor condition and require rebuilding if MSH is desired. It is recommended that the exploitation on this stock group be reduced below levels experienced in recent years. Since there is currently no way of measuring exploitation rate this will mean restrictions in one or a combination of the following fisheries: (i) northern troll; (ii) Alaskan troll; (iii) Area 3 and 4 net; (iv) in-river Indian food; and (v) in-river sport. Rebuilding progress can be assessed in both the in-river test fishery and spawning ground enumerations.

2) The development of an approach to coho management which recognizes the following is recommended:

   (a) the need to establish quantifiable management objectives for coho such as:

      (i) Maximum sustainable harvest (MSH) exploitation rate.
      (ii) MSH escapement targets for key stocks and improvements in systematic escapement estimation procedures.

   (b) the role of enhanced production in stock management.

   (c) the importance of freshwater habitat in coho production.

   (d) the need for on-going monitoring and research.

3) In support of 1) and 2) above PSARC recommends that:

   (a) a key stream program for coho be initiated which monitors escapement, exploitation rate and catch distribution for a representative group of B.C. coho stocks;

   (b) productivity and stream indexing research be conducted in northern and southern B.C. to aid in identifying biological management objectives;

   (c) methodologies be developed to predict abundance and distribution of coho stocks;

   (d) all available biological sampling and fishery data be compiled into a central database;

   (e) the current escapement database for coho be reviewed to determine its usefulness for stock assessment.

4) As an interim measure at least, the development of a habitat based methodology for determining optimum escapements for B.C. coho stocks is recommended (represented by key streams). In the absence of reliable spawner-recruit information this approach is widely used in Washington and Oregon. An extensive inventory of available rearing habitat in key streams is an immediate requirement. Only with this inventory can the results of research in 3)b) above be applied.

5) CWT data is currently a critical component of coho stock assessment. Although the investigation of other stock I.D. methodologies are strongly endorsed, the maintenance of this program at a viable level is essential if management of this species is to progress. Analysis of CWT data should include the following elements:

   (a) time and area stratified estimates of hatchery contribution rates to major fisheries;

   (b) application of CWT data to unmarked wild and hatchery stocks for the purpose of estimating stock composition in major fisheries in both Canada and the U.S.;

   (c) verification of hatchery release and recovery statistics to confirm survival, contribution and exploitation rate estimates.

6) The evaluation of catch data is a very important component of the coho stock assessment process. A knowledge of the regulations which have affected different fisheries over time is essential if this data is to be correctly interpreted. It is recommended that historical fishing patterns be documented so that analysis of this data can proceed.

7) Production from enhancement programs represents a significant and growing portion of coho catch. In order for catch data to be useful in assessing wild stock status the full extent of this enhanced production must be

known. In light of this, it is recommended that all significant enhanced production (smolts or fry) be represented by a CWT group that is similar to it in time, size and location of release, and that escapements of at least a subset of these groups be monitored using techniques with known precision.

8) Recognizing the potential impacts of planted hatchery pre-smolts on wild stocks the development of biological guidelines are recommended which will guide the selection and enhancement strategy of all pre-smolt planting projects. Furthermore, the genetic impacts of hatchery stocks on wild stocks should be studied to ensure optimum long-term production from both sources.

Pacific Stock Assessment
Review Committee

Steering Committee Review of
PSARC Advisory Document 86-4

Advice on Pacific Coho

The advisory document was presented by B. Riddell.

The committee felt that recommendation 3 is the main recommendation. The Steering Committee also recognizes the importance of the conservation issues on the Skeena, Fraser, and east coast of Vancouver Island. Recommendation 4 was not endorsed as it is too broad a recommendation. Inspection of the methodology within selected key streams is recommended. There should also be documentation on #smolt/spawner (i.e. how is habitat inventory translated into an escapement target).

The committee endorses recommendation 5 but points out the limited capabilities for stock I.D. of coho with methods other than using CWT. Thus CWT approach is fully endorsed.

Recommendation 6 is endorsed and is included in the records of management strategies. Evaluation of catch data is a time consuming undertaking. The sub-committee is requested to make further clarification of information requirements and time period to be covered.

Steering Committee is concerned about supporting sweeping recommendations such as 7 and 8. The intent is well founded. Our recommendation is that coho assessment people speak directly to SEP assessment people to discuss specific issues identified during the development of this advisory document. Recommendation 8 requires further evaluation. Programs should be developed through SEP evaluation and salmon assessment.

The report was APPROVED by the committee with the above provisos.

Approved for release by Fisheries Resource Management Executive Committee.

Pacific Stock Assessment
Review Committee

PSARC Advisory Document 86-5

Advice on Barkley Sound Sockeye

This advisory document is the result of work undertaken by the Barkley Sound Technical Working Group (BSTWG) since its formation in 1983. The BSTWG was established by working level scientists and fisheries management staff in response to a general recognition of the need to achieve a greater degree of coordination of activities and information exchange associated with research, enhancement and management efforts focused on Barkley Sound (Area 23) sockeye stocks. Activities undertaken by the BSTWG clearly fall within the terms of reference associated with the recent establishment of the PSARC process. The Barkley Sound Technical Working Group is made up of technical experts from research, management and SEP.

Currently, three Barkley Sound sockeye stocks (Great Central, Sproat and Henderson) are managed within a mixed-stock, mixed-gear fishery operating in Area 23. Intensive management is aimed at (i.) achieving stock specific escapement goals to ensure that future production of sockeye is either maintained or increased, (ii.) meeting the food fish needs of aboriginal peoples resident at Uchucklesit Inlet and especially along the lower reaches of the Somass River and (iii.) achieving a 60% to 40% split of the remaining sockeye to be taken by purse seine and gillnet fleets respectively. As in many locations on the B.C. coast, these objectives are complicated by: intrinsic differences in the productivities of the sockeye stocks contributing to the fishery, interannual variations in stock productivity and uncertainties regarding identification of optimal escapement levels.

Stock History

Total Stock Trends in Barkley Sound

For the 70 year period of record prior to 1972, total returns of sockeye to Barkley Sound averaged 83,952 fish per annum and ranged from 6,526 to 200,151 (Fig. 1). Beginning in 1973, Barkely Sound sockeye exhibited dramatic increases in total returns which appear to be largely attributable to research, management, and enhancement initiatives involving lake fertilization and escapement optimization. Immediately following an initial period (1970-73) of controlled nutrient additions at Great Central Lake, the percentage survival from potential egg deposition to juvenile sockeye increased 2.6 times and the mean stock size of adult sockeye increased from less than 50,000 to greater than 360,000. The magnitude of the increase in adult returns was clearly unprecedented within the eighty plus year period of record for the Barkley Sound stocks and has been sustained over the past 12 years. Since 1983, when a peak stock size of approximately 1.6 million sockeye was achieved, there have been three consecutive years of declines in Barkley Sound sockeye returns due to low marine survivals associated with recent extremes in ocean climate conditions off the southwest coast of Vancouver Island (see comments below).

Catch Trends

Prior to 1972, Barkley Sound sockeye supported a small gillnet fishery with a mean annual catch of only 34,140 fish. Exploitation rates varied between 7% and 58% and averaged 29%. The stock increases that occurred after 1972 permitted the establishment of a major, mixed-gear, net-fishery in Barkley Sound which has supported an average annual catch of 615,000 fish during the past 10 years.

Barkley Sound Catch

Year	Total	Exploitation Rate	% of Total Stock Hend.	GCL	Sprt.
1977	1101211	0.78			
1978	185100	0.54			
1979	727725	0.67			
1980	642800	0.67	4.4	52.7	42.8
1981	919000	0.68	2.9	59.1	38.1
1982	410000	0.47	2.1		
1983	860000	0.57	4.6	55.3	40.1
1984	914602	0.77	5.2	59.7	35.2
1985	367000	0.55	1.8	58.8	39.4
1986	30000	0.06	0	38.1	61.9

During this same period, the commercial catch (excluding 1986) has varied between 185,000 and 1.1 million fish while the exploitation rate (excluding 1986) has ranged between 47% and 79% (Table 1). In recent years the Great Central Lake stock has been the single largest contributor to the fishery (53% of catch), followed by Sproat Lake sockeye (44% of catch), and Henderson Lake sockeye (3% of catch). A precise breakdown of the composition of the commercial catch according to stock or origin is not available for much of the period of record although a number of observations suggest that Henderson Lake sockeye made up a higher proportion of the Barkley Sound aggregate for the entire period prior to 1972 than from 1972 to present. Historical observations indicate that Henderson Lake sockeye contributed more than 30% of the average catch of 70,000 sockeye taken each year between 1926 and 1934. The decline in the proportionate contributions of the Henderson stock to catch has been a consequence of (i.) an absolute decline in the numbers of Henderson fish produced, (ii.) dramatic increases in the total stocks of Great Central and Sproat sockeye and (iii.) attempts by Area 23 managers to protect the Henderson stock from the commercial fishery in recent years.

In addition to the commercial catch, a native food fishery is generally conducted by gillnet and drag seine for sockeye in the Somass River each year. For the period from 1950 to 1982 the reported food fish catch of sockeye averaged 3,800 fish per year (range 150 to 23,800). As in the commercial fishery, increases in sockeye food fish catches have been most

noticeable since 1972 with the ten year average between 1973 and 1982 amounting to 12,350 sockeye. The reported food fish catch is undoubtedly an underestimate of the actual food fish catch as few procedures currently are in place to ascertain the accuracy of the reported landings. However, given the location of the food fishery near well travelled locations along the Somass River as well as the likelihood that gross discrepancies from these catch quantities would be detected in the local marketplace, it is unlikely that the true "food fish" catch would vary from these long term means by more than a factor of 3. In recent years, various native bands involved in the food fishery have negotiated substantial increases in the ceilings on annual food fish catches. In the event that annual catches increase to a significant proportion of total stock, efforts should be made to improve "food fish" catch assessment data.

Age Composition of Catch

Two age groups of sockeye consistently dominate the Barkley Sound catch. For the period 1971-1982, 62.2% of the catch was composed of 1.2 sockeye (range 32.2-90.8%), 34.1% of the catch was composed of 1.3 and 2.2 sockeye (range 6.05-62.4%) and all other age types made up the remaining 3.7% of catch. Unlike many sockeye stocks that return to lakes in the British Columbia interior, jack returns (male 1.1's) to Barkley Sound are generally less than 5% of stock in a given year (x = 1.5%, range = 0.07 - 4.40%). Consequently, information on variations in jack return strength is of little use in forecasting returns to Barkley Sound.

Escapement Trends

The quality of escapement information for the three Barkley Sound sockeye stocks has been influenced to such a great extent by uncontrolled changes in assessment procedures and effort levels that values recorded prior to 1974 for Great Central and prior to 1980 for Sproat and Henderson should be viewed as indicative of only rather general trends in stock-specific escapements.

Barkley Sound Escapement

Year	Total	Henderson	Great Central	Sproat
1977	297800	4800	212200	80800
1978	158900	7000	114400	37500
1979	360441	20000	263995	76446
1980	318736	20760	159597	138379
1981	430191	40354	262287	127550
1982	470261	56065	172269	241927
1983	644987	44987	350000	250000
1984	267524	45122	133306	89096
1985	299719	25000	127758	146961
1986	316361	5000	118420	192941

Henderson Lake

Escapements to Henderson Lake have apparently ranged from 1,500 to 135,000 sockeye (Fig. 2). The large escapements permitted during the period from 1917 to 1935 (mean 56,984; range 4,200-135,000) were a consequence of management decisions to restrict the fishery to maximize escapement to the Henderson Lake hatchery which was operational from 1910 to 1935. Closure of the Henderson Lake hatchery and reduced stock management effort appear to have resulted in a chronic condition of reduced escapements to Henderson Lake between 1936 and 1979 (mean escapement 18,882; range 1,500-75,000). There is considerable uncertainty as to how much of this reduction was real. During the hatchery years escapement enumeration was based on daily inspections of the lakeshore and stream spawning locations. After closure of the hatchery, and for many of the years between 1936 and 1979, escapement estimates were based upon visual counts during one or two aerial overflights in fixed wing aircraft. Recent studies have confirmed that the latter procedure results in estimation errors varying by several fold from one year to the next at Henderson Lake. Thus, even major differences in annual escapements recorded at Henderson Lake between 1936 and 1979 (Fig. 2), may be simply a consequence of enumeration errors. The escapement record during this period should be considered of limited utility.

Starting in 1979 and continuing to present, standardized visual counts and mark-recapture procedures have been employed to estimate the numbers of sockeye using the lakeshore and Clemens Creek spawning grounds. Escapements have averaged 32,161 sockeye since 1979 (range 5,000-56,065). Escapements declined in both 1985 and 1986 due to low stock returns to Barkley Sound. The limited time series of reliable catch and escapement data for Henderson Lake sockeye has prevented direct determination of well defined catch and escapement targets for this stock.

Great Central Lake

Currently sockeye escapements to Great Central and Sproat lakes are recorded within the salmon escapement data system (SEDS) as aggregate returns to the Somass River. However, research staff in Nanaimo and Area 23 managers have assembled stock specific escapement records for Great Central and Sproat sockeye (Fig. 2). Assessments of annual escapements to Great Central Lake were begun in 1927 following completion of the first fishway at Stamp Falls. Observations of escapement since that time have been based on either direct visual counts or the use of electronic counters at the Stamp Falls or Great Central Lake fishways. Escapement estimates between 1929 and 1949 were reported simply as the sum of all hourly counts without regard to between year differences in counting effort expended. Stock specific estimates between 1956 and 1973 were based on the sum of weekly estimates derived from the weekly mean of a variable number of hourly visual counts multiplied by a seasonally adjusted factor for the number of hours sockeye were assumed to actively migrate over the diel cycle. Since 1975, Great Central sockeye escapement estimates have been based on the sum of hourly fish counts recorded continuously by an electronic counter at the Great Central fishway throughout the period of migration. Calibration of electronic counters against visual

counts has been provided by conducting 3-5 hours of visual counts on a weekly basis over the 6 to 12 weeks of the run. Thus, differences in the level of effort expended annually to complete visual or electronic counts, variations in the analytical procedures used to convert hourly counts into annual escapement estimates, and variations in reporting procedures preclude high accuracy comparisons of escapement estimates across a number of the intervals (1929-1949, 1950-1974, 1975-1986) making up the period of record (Fig. 2). Regardless, documentation of procedure and effort differences along with preliminary analysis suggest that escapement estimates within each of these periods are roughly comparable and that escapement differences of greater than two fold between consecutive time periods may be viewed as biologically meaningful.

Between 1929 and 1972, escapements to Great Central averaged 23,674 sockeye per annum (range 1,706 to 100,000). Peak escapements were undoubtedly larger in the latter half of this period (Fig. 2), although the appearance of a general increase after 1949 is in part attributable to differences in analytical and reporting procedures. Major increases in escapements to Great Central after 1972 accompanied increases in total returns associated with lake treatment. Between 1973 and 1986 average escapement increased by more than seven fold (mean 173,238) and peaked with a record breaking escapement of 350,000 sockeye in 1983. Escapements to Great Central have exhibited significant declines in each of 1984, 1985 and 1986.

Sproat Lake

No record of annual escapement estimates specific to Sproat Lake has been found predating 1950 and the construction of the Sproat Falls fishway. Annual estimates reported after 1950 are based upon the summation of weekly estimates determined as either (i.) the weekly mean of hourly visual counts multiplied by a seasonally adjusted factor for the number of hours sockeye were assumed to actively migrate over the diel cycle (1950-1978) or (ii.) the sum of hourly fish counts recorded continuously by an electronic counter maintained at the Sproat Falls fishway exit (1980-present). As at Great Central, the escapement estimates within each of these periods (Fig. 2), should not be viewed as biologically significant unless the estimates differ by at least 100%.

Between 1950 and 1972 the average escapement of sockeye to Sproat Lake was 20,460 (range 5,000-42,600) or approximately half of the annual average reported as returning to Great Central for the same period. As was the case at Great Central, Sproat Lake sockeye exhibited substantial increases in escapement after 1972. Escapements to Sproat Lake averaged 111,300 sockeye between 1973 and 1986 and achieved an all time high of 250,000 fish in 1983. The escapement achieved in 1984 (80,096) was considerably lower than the most recent 10 year average but achieved values well above this level in both 1985 and 1986.

Definition of Escapement Targets

Well defined stock-recruitment relationships do not exist for the Barkley Sound sockeye populations due to the limited time series of reliable observations of catch and escapement by stock. Furthermore, periodic variations in marine survival patterns are likely to preclude definition of useable stock recruitment functions even given access to longer time series observations. In the absence of useable stock recruitment relationships, escapement targets prior to the late 1970's appear to have been set arbitrarily on the basis of historical precedent and largely without reference to any objective assessment of the productive capacity of the stocks. For example as recently as the late 1970's escapements greater than 25,000 sockeye to Henderson Lake or 50,000 to either Great Central or Sproat Lakes were considered excessive. Research conducted by the sockeye stock assessment group since 1976 in conjunction with the Lake Enrichment Program has produced refinements in determination of the carrying capacity of both fertilized and untreated coastal lakes for juvenile sockeye. Consequently, escapement targets have been revised upwards on a number of occasions since 1980 and are currently set at 200,000 sockeye for Great Central, 150,000 for Sproat and 65,000 for Henderson.

Hydroacoustic and trawl based estimates of annual smolt production in Great Central Lake since 1974 and Sproat Lake since 1980 indicate that both lakes may be expected to sustain linear increases in smolt output to escapement levels of at least 150,000 fish. Prior to the record breaking escapements of 1983, it appeared that escapements in excess of 200,000 sockeye in either system would not produce increases in smolt output. However, escapements of 350,000 sockeye to Great Central and 250,000 to Sproat Lake in 1983 resulted in substantial increases in smolt output from both lakes in the spring of 1985 and suggest that escapement targets may still be increased by 50,000 to 100,000 fish above existing targets without obvious loss of productive capacity. The relationship between escapement and smolt output at Henderson Lake is based upon fewer observations but also suggests that an escapement as high as 55,000-60,000 adults is not excessive. Increasing production from the Henderson stock appears to depend on continued protection to increase escapements. Low marine survivals and recent declines in escapements (1985,1986) constitute a temporary setback. However, efforts to protect this stock and to increase escapement should not be abandoned if future production gains are to be realized.

In spite of advances in setting escapement objectives for Barkley Sound sockeye, many uncertainties remain. Escapement management and enhancement techniques such as lake fertilization may be used to either maximize the numbers or the size of sockeye smolts produced. It is not clear at this time which precise combination of sockeye smolt numbers and size will maximize the benefits in terms of biomass of returning adults to Barkley Sound or to any other stock of sockeye along the British Columbia coast. Management for increases in escapements to the three Barkley Sound stocks has contributed to increased stock production and thus far has not resulted in any clear reduction in within lake survival of juvenile sockeye. However, there has been a modest impact on smolt size. Research on factors controlling marine survival variations and especially on the effects of juvenile sockeye size

(and time) at migration is required to permit further advances in the definition of optimal escapement levels for these and other coastal sockeye stocks.

Forecasting

Forecasts of salmon returns to Barkley Sound prior to the fishing season provide reference points for (1) establishment of an initial schedule of fishery openings, (2) planning by industry for harvesting and (3) comparisons of stock performance during the fishing season such that catch and escapement goals may be adjusted in the face of return variations to adhere to multiyear management objectives. Forecasts of salmon returns are frequently based on historical observations of the average returns per spawner of average survival from the smolt to adult stage. Stock specific pre-season forecasts of Barkley Sound sockeye returns have been based upon such average performance indicators since at least 1978 with apparently satisfactory results. However, returns of adult sockeye to Barkley Sound during 1985 and 1986 fell far short of pre-season expectations. In 1985 only 700,000 (44%) of the 1.6 million sockeye expected returned and in 1986 only 346,000 (32%) of the 1.1 million sockeye expected returned. The low returns have complicated the management of the fishery and have created considerable uncertainty for managers about what levels of sockeye production to expect in the immediate future. The magnitude of the return shortfalls relative to expectations in 1985 and 1986 indicates that the simple algorithms used to forecast sockeye returns to Barkley Sound in recent years require further modification to improve their utility and steps have been taken to do so (see comments re: 1987 prognosis below).

In-season Management Procedures

Given the uncertainty of recent pre-season forecasts, in-season acquisition and interpretation of stock assessment information has been especially critical to the identification of rapidly changing management options for adherence to multiyear management objectives within a given fishing season. In the years immediately prior to 1984, in-season management of the Area 23 net fishery was based upon indices of sockeye abundance such as catch per unit effort in the fishery and especially cumulative escapement past electronic counters at Sproat Falls and the Great Central Lake fishway. The approach was largely qualitative and intuitive as it presumed, in spite of the absence of any analytical support, that a significant relationship existed between rough approximations of daily or weekly catch per unit effort and total abundance of sockeye. Then, as now, no standardized test fishery methodology had been developed to provide in-season forecast revisions similar to those used for management of either the Fraser or Skeena commercial fisheries. Consequently, openings were planned on the basis of pre-season forecasts and decisions for closure were often predicated on perceptions of poor progress towards achievement of escapement objectives to Sproat and Great Central in an atmosphere of uncertainty about the quantity and stock composition of sockeye present in the terminal fishing area.

Since 1984, the process of assembling and analyzing the information necessary to make in-season management decisions has been aided through the development and implementation by BSB personnel of a return timing model. Catch and escapement data are used in the model to forecast weekly and total abundance of returns for each of the Barkley Sound sockeye stocks. Application to the 1985 fishery indicated that, although forecasts from the model were sensitive to return timing assumptions, curtailment of the fishery was correctly advised by the fourth of seven scheduled fishery openings. The achieved exploitation rate of 56% was less than the 77% pre-season forecast and reflected lower than expected returns. Temporary pooling of sockeye between the fishery and escapement enumeration sites, possibly due to high temperatures in the Somass River, biased downwards the in-season return forecasts. Application of the model in 1986 indicated as early as July 7th a 764,000 fish shortfall relative to the pre-season forecast and supported the decision for no further fishery openings for the season. Although improvements to the model are still desirable, it currently provides an objective basis for management of the Area 23 net fishery through use of data on size of catch, catch composition by stock and daily escapements to Great Central and Sproat Lakes.

Stock Status in 1986

Total returns of approximately 346,000 sockeye to Barkley Sound in 1986 were only 35% of the most recent ten year average thus continuing the pattern of decline initiated in 1984. Identification of this situation early in the fishing season and prompt closure of Area 23 resulted in a catch of only 30,000 sockeye and minimized shortfalls in escapement such that the aggregate escapement of 316,361 was only slightly lower than the ten year average of 356,492 for the period from 1977 to 1986. Initial analysis suggests that the marine survivals for Henderson, Great Central and Sproat sockeye were approximately .6%, 1.3% and 1.8% respectively as compared with a multiyear average prior to 1984 of approximately 5%. The differential rates of return resulted in varying degrees of success in achieving stock specific escapements i.e. escapements to Henderson, Great Central and Sproat Lakes achieved 8%, 59% and 129% of stock specific targets respectively. Actions taken in 1986 to minimize catch and protect escapements should ensure reasonable prospects for rebuilding the Barkley Sound stocks as marine survivals move away from the extremely low values experienced in recent years.

Prognosis for 1987

Adult sockeye returns to Barkley Sound in 1987 will be derived from the moderate magnitude smolt release of 1984 (returning as 1.3's) and the record breaking 1985 smolt release (returning at 1.2's). There is considerable uncertainty regarding the returns forecasted for 1987. If marine survivals revert to the average observed between 1970 and 1983 (about 5%), then in excess of 1.3 million sockeye could appear to support a catch in excess of 900,000 fish. However, if recent marine survival levels apply (about 2.5%), then only 600,000 to 700,000 sockeye are likely to return to support a catch of about 250,000.

Two lines of analysis suggest the low return level is more likely in 1987. First, assembly and analysis of an approximately 80 year time series on return variations of sockeye to Barkley Sound indicates that multiyear intervals of below and above average returns have occurred periodically since the early 1900's. Time series analysis also indicates that, once entered, a sub-average return interval has a greater than 70% chance of persisting for an additional 4 years i.e. in the present situation, until 1988 or 1989. Second, measurements of both freshwater and marine survival levels for 3 to 5 sockeye stocks originating from the southwest coast of Vancouver Island since 1980 confirm that the recent declines in returns are attributable to marine rather than freshwater events. There are indications that shifts from below average to above average returns are associated with changes from above average to below average marine temperatures during the period of seaward migration by smolts. Since the 1984 and 1985 year classes of smolts that will give rise to the 1987 returns still encountered slightly above average marine temperatures, it is most likely that low marine survival rates will continue to influence the 1987 returns.

Status, Utility and Maintenance of the Barkley Sound Stock Assessment Data Base

The time period since 1972 has witnessed the greatest changes in Barkley Sound sockeye stock size and has been accompanied by the development and application of an increasingly detailed stock assessment data base for effective forecasting and in-season management of the fishery (summarized in Table 1). The data base used to achieve stock specific management objectives (Table 1) has been largely generated since 1970 on a collaborative basis between SEP-FRB-FSB in association with enhancement initiatives in the form of lake fertilization by FRB (1970-73) and more recently by SEP (1976 to present). Since 1977 SEP has underwritten much of the roughly $100.K annual cost for FRB to generate index data with additional expenditures for their analysis and inclusion in reports.

SEP has frequently been criticized for creating manageability problems. Consequently, the purpose of the above efforts has been to demonstrate that mixtures of "wild" and enhanced salmon stocks, differing radically in productivity, can be successfully managed given development of the appropriate information and management tools. This objective has been largely realized in recent years through development of: (1) improved stock return forecasting techniques, (2) parasite "tags" to enable assignment of mixed stock catch to stock of origin, (3) in-season, return timing indices (e.g. Hobiton & Henderson stock return timing indices) and (4) a run-timing model to permit weekly revisions, in-season, of expectations for returns by stock and to identify allowable catch.

There are still improvements to be achieved in development of the data base for management of Barkley Sound sockeye (e.g. items 10 & 11 in Table 1), however, greater concern must be attached to long term maintenance of the existing data base. Although SEP and the Science Branch (SB) have invested in a successful collaboration with the Fisheries Branch (FB) in developing techniques for acquisition and application of the present data base, they have

no long term mandate to maintain it. This responsibility clearly lies with FB and will become increasingly apparent as SEP and SB reduce support for acquisition of items increasingly viewed as routine operations data in support of FB management activities. For example, SEP funds were not available to support assessment of the Great Central Lake escapement during the 1986 season and neither the Great Central or Sproat escapement assessments will be fully supported by SEP-SB in 1987.

In spite of these changes it is in the best interest of the Department to identify ways in which to maintain the Barkley Sound sockeye data base in the long term. For example, commercial catch sampling and the use of tissue bioassays to assign weekly catch to stock of origin on the basis of parasite "tags" (item 6, Table 1) should now be viewed as essential to effective in-season management of Barkley Sound sockeye on a routine basis, not just in exceptional years. Failure to continue acquisition of these data largely eliminates the opportunity to use the run-timing model to make stock-specific management recommendations in-season and would constitute a regression to managing the three Barkley Sound sockeye stocks as if they were a single stock. There are major economic repercussions to such a development. For example, in 1987 Sproat, Great Central and Henderson sockeye are expected to make up 54%, 32% and 14% of returns respectively. Given this imbalance, application of an exploitation rate that leaves just enough fish to meet Sproat Lake's escapement objective would produce a 50% shortfall in meeting the Great Central escapement objective. Given a return per spawner range of 2-4 this would result in a loss of sockeye production on the order of 200,000 to 400,000 fish equivalent to a landed value between 2 to 4 million dollars in 1991 and 1992. Thus, it is important to know during the 1987 season the extent to which the Sproat, Great Central or Henderson returns are out of balance. Loss of real time observations on in-season stock composition in the catch to save the 10-15 K cost of sampling would represent false economy.

We are currently in a period of extreme fiscal restraint. Accordingly, the view may be taken that the Department cannot afford to find the resources necessary to maintain the data base to ensure effective management of Barkley Sound sockeye. However, it should be apparent that failure to do so will in the long run relegate the Barkley Sound stocks to production levels of only 50-60% of their potential annual yield and result in annual financial losses to the fishing industry that far exceed the annual costs associated with maintenance of the current data base.

Reviewers Comments and Research Recommendations

Reviewers Comments:

Stock assessment procedures developed for Barkley Sound sockeye in recent years are generally sound and include many significant improvements over those employed in earlier time periods (e.g. prior to 1980). A well defined multiyear stock assessment data base has been created which provides a framework for (i.) effective management of three Barkley Sound sockeye stocks such that their long term productivity will likely be sustained or increased

and (ii.) continuing research on both freshwater and especially marine processes controlling recruitment variability of sockeye. Recommendations are as follows:

(1) The multiyear data base (Table 1) currently serving as the basis for management of Barkley Sound sockeye stocks should be maintained on an annual basis.

(2) Considerable attention should be given to adherence to standardized procedures developed in the past few years for acquisition, assembly and analysis of the several types of stock assessment data. This is especially critical as responsibilities for assessment routines involving: retrieval of representative samples from the commercial fishery, operation of electronic fish counters on the Somass or mark recapture efforts at Henderson Lake transfer from Science Branch to Fisheries Branch personnel.

(3) Enhancement initiatives in the form of lake fertilization by FRB (1970-73) and more recently by SEP (1976 to present) have altered, but not eliminated, stock productivity differences. Therefore, the stock specific approach to management of Barkley Sound sockeye should be maintained and refined.

(4) Application of the run timing model for in-season management should be refined by (i.) incorporating more years of run timing observations into the current average run timing curve (ii.) conducting additional analysis to identify the magnitude and causes of year to year variations in Somass sockeye return timing.

(5) Development of hydroacoustic survey techniques or of a standardized test fishery is required to provide in-season abundance estimates of sockeye in the terminal fishing area at times or locations not covered by commercial openings.

(6) The practice of weekly consultation between FRB researchers and Area 23 managers and biologists during the fishing season should be continued in 1987.

Research Recommendations:

(1) Objective escapement targets have been defined for each of the three Barkley Sound sockeye stocks; however, optimal escapements have not. Therefore, as opportunities permit, escapements should be increased to obtain more information on just where the optima lie. As an aside, separate escapement estimates for Great Central and Sproat should be entered into SEDS annually rather than just an aggregate figure for the Somass.

(2) It is very difficult to forecast annual returns of sockeye accurately because so many biological and environmental factors are involved. Separation of recruitment variability of Barkley Sound sockeye into freshwater and marine components has confirmed that recent recruitment declines have been primarily due to processes occurring in the marine environment. Recent recognition that recruitment variations have some degree of coherence with long term variations in ocean climate (as indexed by temperature) has aided in identification of a

number of testable hypotheses about biotic and abiotic mechanisms that may be controlling patterns of return variations of sockeye originating from Barkley Sound as well as other rivers and lakes along the southwest coast of Vancouver Island. A long term research project will be initiated in 1987 to investigate the effects of oceanographic conditions on interannual variations in recruitment of salmon and especially sockeye originating from these lake and river systems. Coded wire tag (CWT) studies should be initiated along with other studies to investigate the associations between marine survival variations and variations in the timing, size, or location of origin of migrating sockeye smolts. Due to cost and logistics considerations, studies on small stocks of sockeye located immediately north and south of Barkley Sound (Hobiton, Cheewhat and Muriel Lake sockeye) should be supported as experimental analogues to the larger Barkley Sound sockeye stocks.

(3) Logging activities recently initiated in the Clemens Creek watershed have the potential for serious impacts on the incubation environment and overall production of Henderson Lake sockeye. Current stock assessment procedures, including hydroacoustic and trawl based estimates of sockeye smolt output, permit separation of productivity changes due to freshwater as opposed to marine events and should be maintained to improve the chances of identifying productivity changes attributable to future logging activities. Additional attention should be given to support of research activities which would more precisely define the nature of logging impacts on Henderson Lake sockeye.

Table 1.

INDEX DATA TYPE	CURRENT USE	CONSEQUENCES OF DELETION (or ADDITION)	CURRENT SOURCE
1. Smolt abundance, size and age by stock.	Pre-season forecasts of annual returns by stock. Marine survival calculations. Freshwater survival conditions.	Loss would (i.)require that pre-season forecasts be based on more variable return-spawner $^{-1}$ data and (ii) result in an inability to identify whether adult return variations are attributable to marine or freshwater events.	Ongoing hydroacoustic, trawl and smolt surveys by SEP-FRB (e.g. Hyatt et al.1984,Hyatt & Stockner 1985, Hyatt & Rome, unpublished).
2. Mean ocean age at return by stock.	Pre-season forecasts of annual returns by stock. Marine survival calculations.	As above.	Ongoing catch and escapement sampling by SEP-FRB-FSB. (e.g. Manzer 1976, Steer et al. 1986, Hyatt et al. in prep.).
3. Mean return by stock based on weekly catch and escapement estimates.	Input to run-timing model to produce pre-season forecasts of weekly returns by stock and in season reforecasts of weekly returns by stock.	Termination of any further improvement in run-timing model data for stock management purposes.	As above.
4. Weekly escapements to Great Central and Sproat Lakes.	Input to run-timing model for weekly revisions of in-season forecasts by stock. Marine and freshwater survival calculations.	Loss of these estimates would compromise ability of managers to make in-season decisions about (i.) progress in meeting annual escapement objectives for GCL and Sproat stocks (ii.) revisions in return forecasts from the FRB return timing model.	As above. Run-timing model as per Steer & Hyatt, draft MS.

Table 1. (Continued)

INDEX DATA TYPE	CURRENT USE	CONSEQUENCES OF DELETION (or ADDITION)	CURRENT SOURCE
5. Weekly estimates of Barkley Sound sockeye catch.	As above.	As for (ii.) above.	FSB hailed catch estimates.
6. Stock composition of catch by commercial opening and gear.	Critical data as above. Also timing and magnitude of Henderson stock contribution serves as a clue to whether Barkley Sound returns are early, on-time, or late.	Loss would eliminate ability to: (i.) assign catch by week to stock of origin (ii.) determine, in-season, whether Barkley Sound sockeye returns are early, on time, or late.	SEP-FRB catch sampling and processing for stock-specific parasite "tags" (e.g. Steer et al. 1986, Quinn et al. 1987, in press).
7. Age composition of catch by commercial opening and gear.	Post-season assignment of production to brood year of origin. Important for marine survival calculations if catch by stock is known.	Loss would result in reduction of accuracy of marine survival estimates since age composition from escapement samples would be used to represent age composition of catch.	Ongoing commercial sampling by SEP-FRB and "test fishery" sampling by FSB.
8. Annual estimates of Henderson Lake sockeye escapement.	Marine and freshwater survival calculations. Management of Henderson stock for maximal production.	Loss would eventually result in loss of most production from Henderson stock.	Annual mark-recapture estimate of escapement by SEP-FRB.
9. Estimates of weekly catch, escapement and age composition of Hobiton Lake sockeye returns.	Early indicator of whether (i.) Barkley Sound sockeye returns will be early, on-time, or late (ii.) marine survivals will be high, average or low. Information is available at about the time of the 4th weekly opening in Barkley Sound.	Elimination would result in loss of an important "early warning" index of early, on-time or late return-timing of sockeye to Barkley Sound.	Annual fence-counts and Indian catch sampling by SEP-FRB.

Table 1. (Continued)

INDEX DATA TYPE	CURRENT USE	CONSEQUENCES OF DELETION (or ADDITION)	CURRENT SOURCE
10. Hydroacoustic estimates by week of adult sockeye abundance in Sub Area 23-1.	Not currently part of annual program.	Addition of this information would reduce uncertainties regarding run-timing. At present high temperatures in the Somass River may cause serious delays for in-season escapement assessments with the result that uncertainties regarding progress towards achievement of escapement objectives arise.	Only preliminary trials for gear development conducted to date by Kieser & Mulligan of FRB.
11. Test fishery abundance estimates in Area 23.		Long-term (7-10 years) development of a well designed test-fishery would eventually provide observations that would reduce in-season uncertainties regarding stock return strength prior to last quarter of fishery.	Currently under development by Heizer & Mitchell of FSB.

* Since 1977 annual costs of providing various types of index data (items 1-4 and 6-9) have been incurred largely through private sector contracts funded by S.E.P. and managed through F.R.B. Accordingly, the $100,000. cost is estimated in terms of 1986 contract support equivalents and reflects expenditures on both professional services and disbursements. Division of cost estimates by 2 provides a rough conversion to estimate costs of completing all assessments in-house given an ongoing commitment of approximately 2 py's of DFO manpower in addition to those currently identified as part of the Area 23 staff allotment.

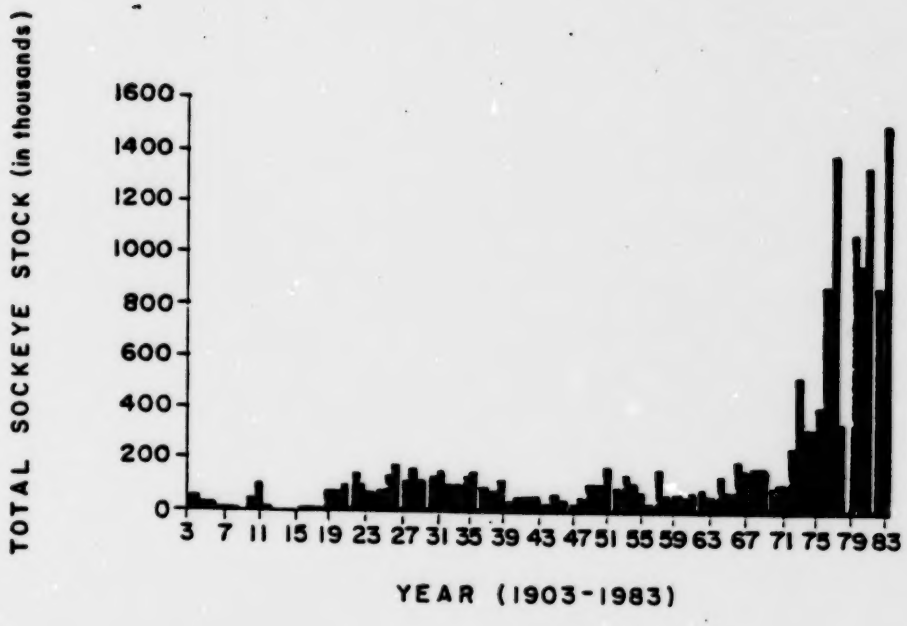


Figure 1. Unadjusted annual estimates of total returns of sockeye to Barkley Sound between 1903 and 1983. Observations include: catch estimates only from 1903-1917, total catch plus Henderson escapement only from 1917-1926, total catch plus Henderson and Great Central escapements from 1926-49, total catch plus escapements to Henderson, Sproat and Great Central Lakes from 1950-83.

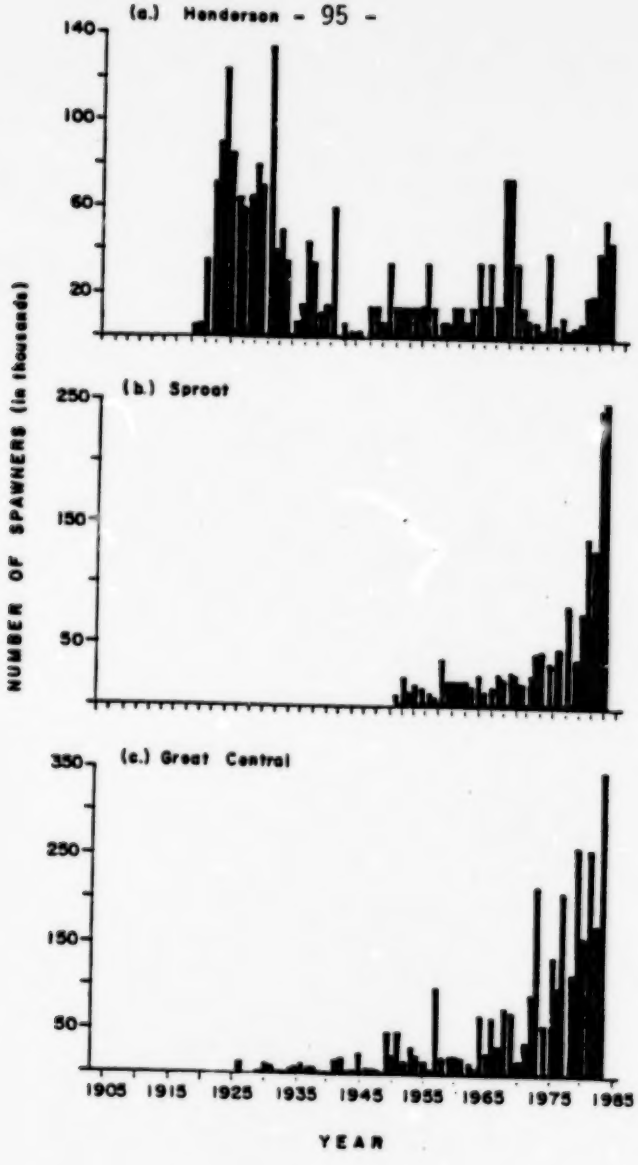


Figure 2. Historical trends in annual sockeye escapements to (a.) Henderson Lake, (b.) Sproat Lake and (c.) Great Central Lake. Escapement estimates were assembled from a variety of both published and unpublished sources (see methods) and the values are reported here without adjustment. It is known that both procedures and effort levels associated with escapement assessments have changed systematically over the period of record; consequently, values presented here should be viewed as indicative of only rather general trends in stock-specific escapements (Hyatt et al. unpublished observations). Few, if any, sockeye routinely reached Great Central Lake prior to construction of the Stamp Falls Fishway in 1927. No quantitative record of sockeye returns to Sproat Lake prior to construction of the Sproat Falls Fishway in 1950 has been found (b.).

Pacific Stock Assessment
Review Committee

Steering Committee Review of
PSARC Advisory Document 86-5

Advice on Barkley Sound Sockeye

The advisory document was presented by B. Riddell.

The committee accepted the document but requests further that:

i) periodicity of marine environment be incorporated into forecasting procedure.

ii) comments are made on production potential.

iii) test fishing capabilities for reliable early detection of run size without reliance on commercial fishery are provided.

iv) assessment of logging effects on sockeye can be studied if Fish-Forest interaction people were notified of this opportunity.

The report was APPROVED by the committee.

Approved for release by Fisheries Resources Management Executive Committee.